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(LEFT TO RIGHT) Secretary, Jules W. Lindau III; of Southern Plastics Co., Inc., and on the faculty of the University of South Carolina; Vice-President, Ernest P. Moslo, Moslo Machinery Co., and Mid-America Plastics, Inc.; President, Frank W. Reinhart, Chief Organic Plastics Division, U.S. Bureau of Standards; and Treasurer, Haiman Nathan, Atlas Plastics, Inc.

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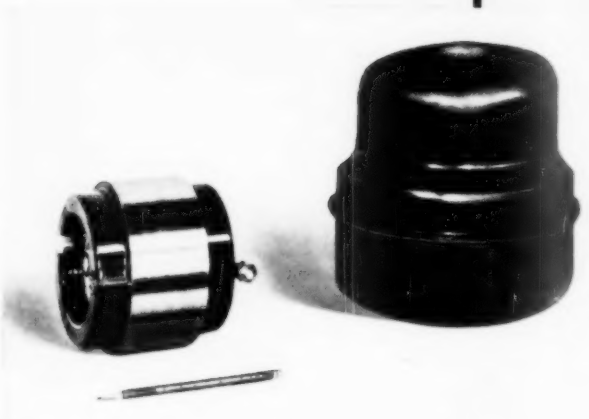
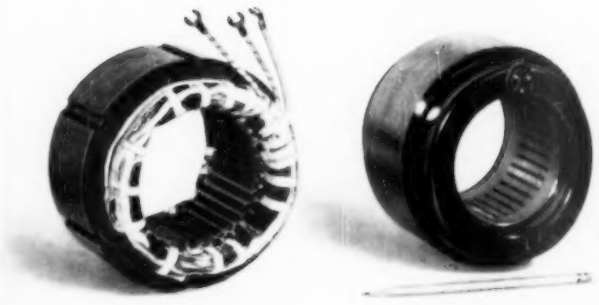


New Compressor (left) takes only 27% of the space of a conventional unit (right). It has only 10% as many parts, weighs 58% less, and will cost much less to produce.

Assembled stator (left). Finished stator (right) has been potted with Epon resin formulation. New compressor was developed by Wetmore Hodges and Associates, Redwood City, California.



Why not combine the pump and the motor? Put a gear pump *inside* the motor stator, encase the stator in plastic, and you can build an entire motor-compressor in the space occupied by a conventional motor alone!

Wetmore Hodges and Associates have done just that. But along the way, they ran into an unexpected problem. With the motor stator doubling as the pump housing, it had to be pressure tight . . . free of voids. This was impossible to achieve with standard potting compounds.

After hundreds of plastic formulations were tried, an Epon resin-based compound solved the problem. The Epon-impregnated stator proved to be pressure tight, stable mechanically and fully resistant to Freon at 350 psi, at temperatures as low as –20° F and as high as 250° F. Important too, Epon resin has excellent dielectric properties; is impervious to air, oil and water.

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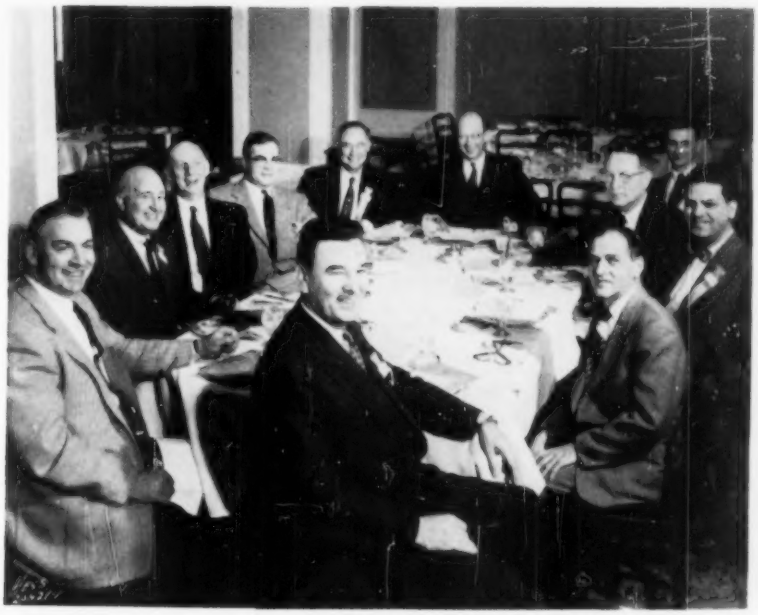

Presidents Luncheon at the 11th SPE National
clockwise around the table from far left).
1952, William Hoey 1945, Charles C. Henry
1949, John LaBelle 1954, Walter Oelman 1953,
xecutive Secretary, J. H. DuBois 1949, Frank
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Attending the Past Presidents Luncheon at the 11th SPE National Conference (reading clockwise around the table from far left). William O. Bracken 1952, William Hoey 1945, Charles C. Henry 1944, Mario Petretti 1949, John LaBelle 1954, Walter Oelman 1953, P. J. Underwood, Executive Secretary, J. H. DuBois 1949, Frank Reinhart 1955, George W. Clark 1946, and Islyn Thomas 1951.

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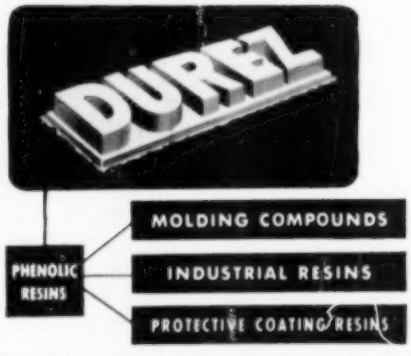

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Book Reviews . . . .

MECHANISM OF POLYMER REACTIONS

G. M. Burnett—Vol. III of High Polymers XV—192 pages. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y. 1954—$11.00.

The new edition of Volume III of the High Polymers series will make a fine addition to the library of those interested and concerned with the kinetics and mechanisms of polymer reactions. The intention of the author, as stated in the preface, to search out general principles and fill in the background with specific examples has been accomplished in a most adequate fashion. That certain phases of the subject were given only passing treatment, is regretted; but the author is to be commended for his judgement not only to avoid duplication with other volumes in the series but also to keep the volume within a reasonable size.

The mathematical treatment throughout the book is in considerable detail and the experimental methods involved in the study of polymer reactions are emphasized, described and referenced. The test is liberally illustrated with pertinent figures, structural formulas, and tables of data. The literature references are many and adequate. The author and subject index are quite good.

The text is divided into twelve chapters covering general kinetics; experimental methods; addition radical polymerization, rate constants, and kinetics of the same; gas phase polymerization; copolymerization; homogeneous and heterogeneous liquid phase polymerization; ionic and condensation polymerization; and degradation of high polymers. The chapters on copolymerization, rate constants of radical polymerization reactions, and degradation of high polymers are particularly noteworthy for the mathematical treatment and clarity.

The complex and involved nature of the subject of mechanism of polymer reactions has been precisely and nicely covered by the author. The volume will be a really reference for those working in the field and an excellent introduction to those who wish to become acquainted with the subject.

Robert Steinman

Across the Editor's Desk . . . .

• Claustrophobia is brought on by being enclosed by a too-small space. Your Editor has crept into this corner to make room for a few highlights of SPE's really great 11th Conference, which are told beginning on page 5.

What really hurts is that we have many fine articles and no room. To squeeze in as much as possible we've cut Plastics Around the World to one page, left out the Molderscope, and trimmed all around. We hurt like a size 7 dame in size 5 shoes.

We're looking toward fatter issues ahead with a gleam in our eye.

Your one chance to read all the Conference articles is to get the 530 page book of preprints. Use the convenient order form bound in the magazine.

SPE Conference Is Host To 1700

For the **eleventh** consecutive year we can tell the story of the SPE Conference in the same two words "Biggest—Best." The reason is that the SPE has grown every year in membership, prestige and recognition by the industry it serve. And each Conference has learned from, and built on, all the preceeding Conferences.

The 11th Conference, held in Atlantic City last January 19-21, was attended by 1,700 individuals, who attended the three sessions presenting a total of 60 papers. Attendance at the technical sessions was at an all-time high, with a large and interested audience at each presentation.

There were a good many highlights of the Conference, some of which were:

Preprints of the talks were available at the Conference in the form of a 530 page book, paper-bound, complete with illustrations and graphs. Copies are still available. Cost to members is three dollars; to non-members, seven and a half dollars.

Because of the great number of papers presented at the Conference, less than half of them can be printed in the SPE Journal. Of the balance, several will appear in the next few months in Plastics Technology and Modern Plastics, while others may appear only in European magazines. The only way to be sure of getting them all is to buy the Preprints. Write to SPE, 34 East Putnam Ave., Greenwich, Connecticut.

The annual banquet was attended by 750, who heard Brigadier General C. J. Bondley, Jr. of the Strategic Air Command describe the organization and purpose of that command, which is primarily to maintain an air force capable of delivering atomic and regular bombs to any point on the earth with devastating speed and accuracy.

Luncheon speaker John La Cerda, public relations expert said; The main thing is to do a good job, and see to it that the public is made aware of that fact. Public relations

(Please turn to page 6)

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Conference . . .

(Continued from page 5)

can do nothing for the outfit doing a poor job. Specifically, about plastics, "your industry needs more policing. There have been too many persons who flooded the market with inferior products. . . . Good public relations, like making friends, is the result of gradual development in which casual acquaintanceship ripens into friendships through many acts of courtesy and helpfulness."

The Conference was opened with a talk by John LaBelle, retiring SPE president, who recounted the principal developments in resins and techniques during 1954, including the development of cross-linked, heat-resistant polyethylene, the urethane rubbers, caprolactam, and the urgent need of training competent new manpower for the plastics industry.

Charters were presented to three new SPE sections at the annual banquet, the Pacific Northwest, the Kansas City and the Central Indiana. More about them on page 28.

"The man in the red vest" who did a real job at the Conference signed up **118 new members.** "The man" being membership chairman Joe Healey, of course, who really stays on the job—signed up the last two at the airport while catching his plane!

The support of the companies in the plastics business is essential to the success of any Conference, and we are very pleased to say thanks to the companies registered at the Conference, and to those which donated door prizes and table favors.

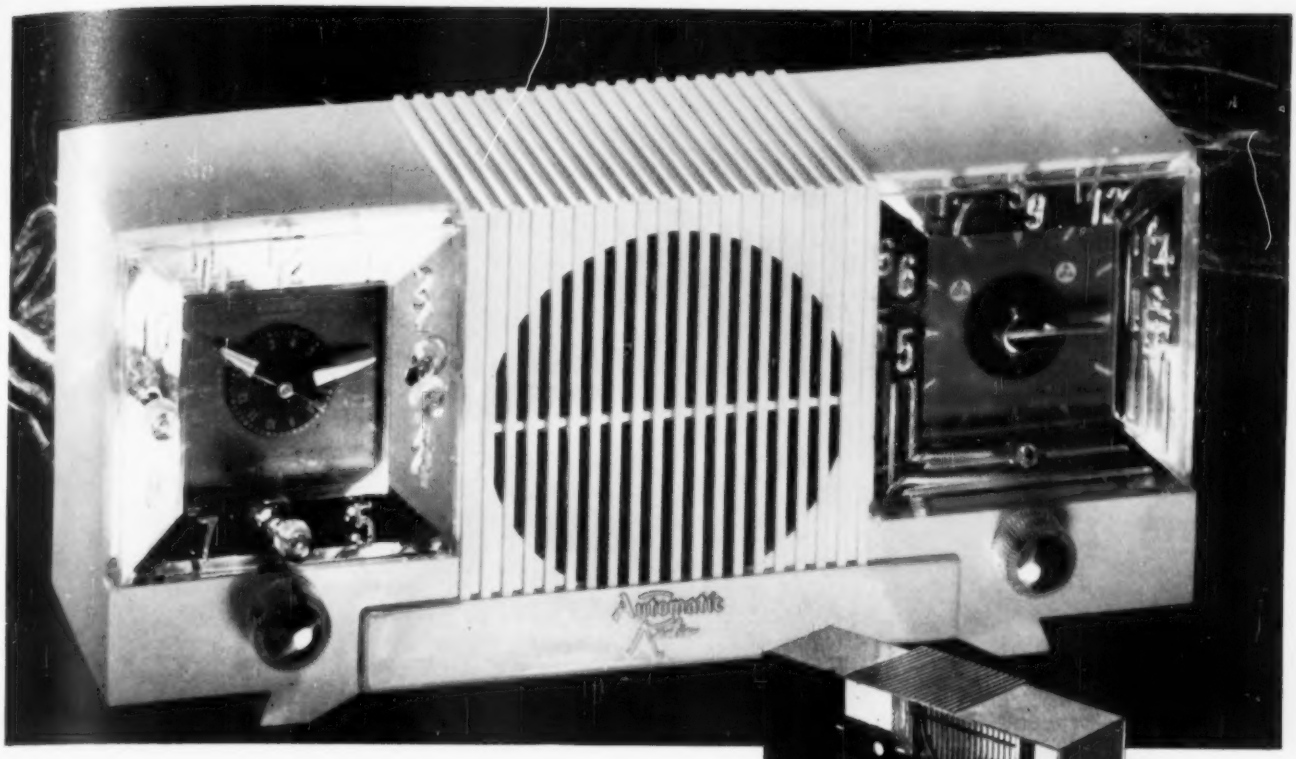
Our good friend-by-correspondence Dewey Rainville, long-time SPE member and strong supporter, was surprised to find the Rainville Co. not listed in the program as registered at the Conference. Unintentional, of course—on page 8 things are okay at last!

And thanks to Bolta who supplied vinyl film for the large banners and Stanley Chemical for the ink thereon.

Akron Rubber and Plastics Meeting

The Subcommittee on Rubber and Plastics of the Committee On General Industry Applications, American Institute of Electrical Engineers, will hold its Seventh Annual Technical Conference in the Mayflower Hotel, April 4 and 5, 1955.

The program will consist of a keynote address, presentation of eight (8) technical papers with prepared and informal discussions of each, a banquet at 6:30 P.M., April 4th, and an inspection trip during the afternoon of April 5th through some local manufacturing plant.



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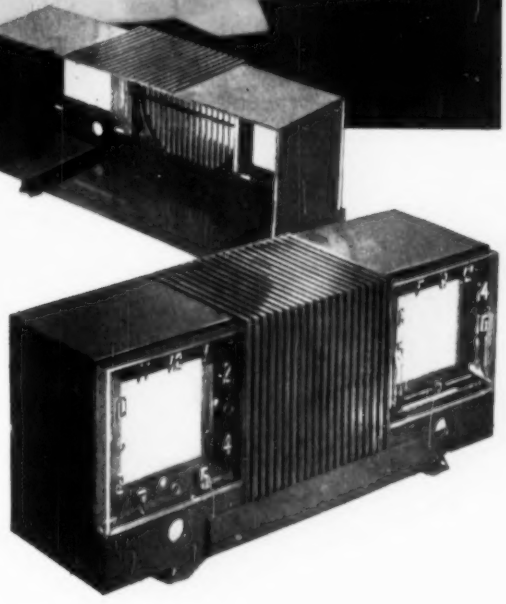

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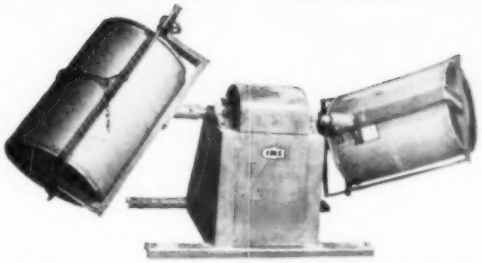

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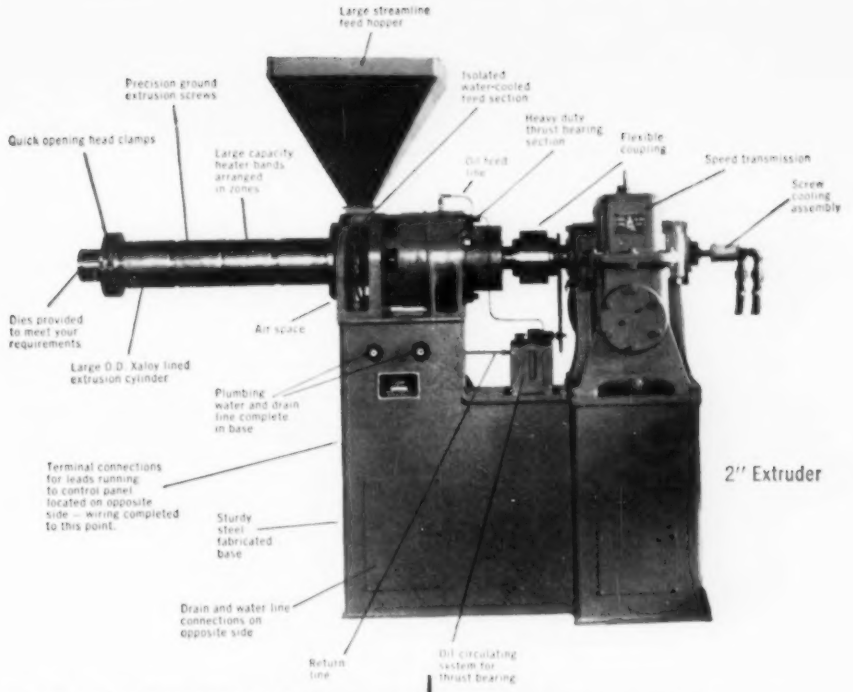
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Isolated water-cooled feed section
Quick opening head clamps
Heavy duty thrust bearing section
Flexible coupling
Speed transmission
Large capacity heater bands arranged in zones
Oil feed line
Screw cooling assembly
Dies provided to meet your requirements
Air space
Large O.D. Xaloy lined extrusion cylinder
Plumbing water and drain line complete in base
Terminal connections for leads running to control panel located on opposite side — wiring completed to this point.
Sturdy steel fabricated base
Drain and water line connections on opposite side
Return line
Oil circulating system for thrust bearing

2" Extruder

compare with the covers off!

Yes, when you remove the covers and get down to the bare facts of construction of this unique extruder, you will find a machine which will have longer effective screw lengths, greater maximum heating capacity, and larger thrust bearing capacity. This will add up to higher production rates, better products, and lower maintenance and operating costs. With the flexible design of the "extrusion" unit consisting of the separate components; screw, heating cylinder, feed section; and thrust bearing housing, we can give you any combination to meet your requirements.

EGAN EXTRUDERS are supplied complete with a *wired* control panel including the main disconnect switch, fuse blocks, contacts and temperature controls *mounted*. Plumbing for the water supply and return lines to the drain are completed in the base. Installation costs are held to a minimum.

EGAN EXTRUDERS can be furnished with dies, conveyors, take-off equipment and other auxiliary features for a wide range of extruded products.

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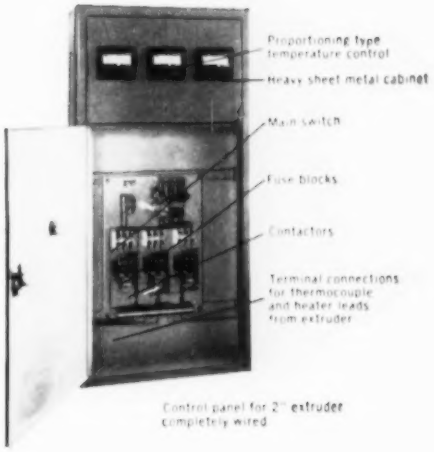
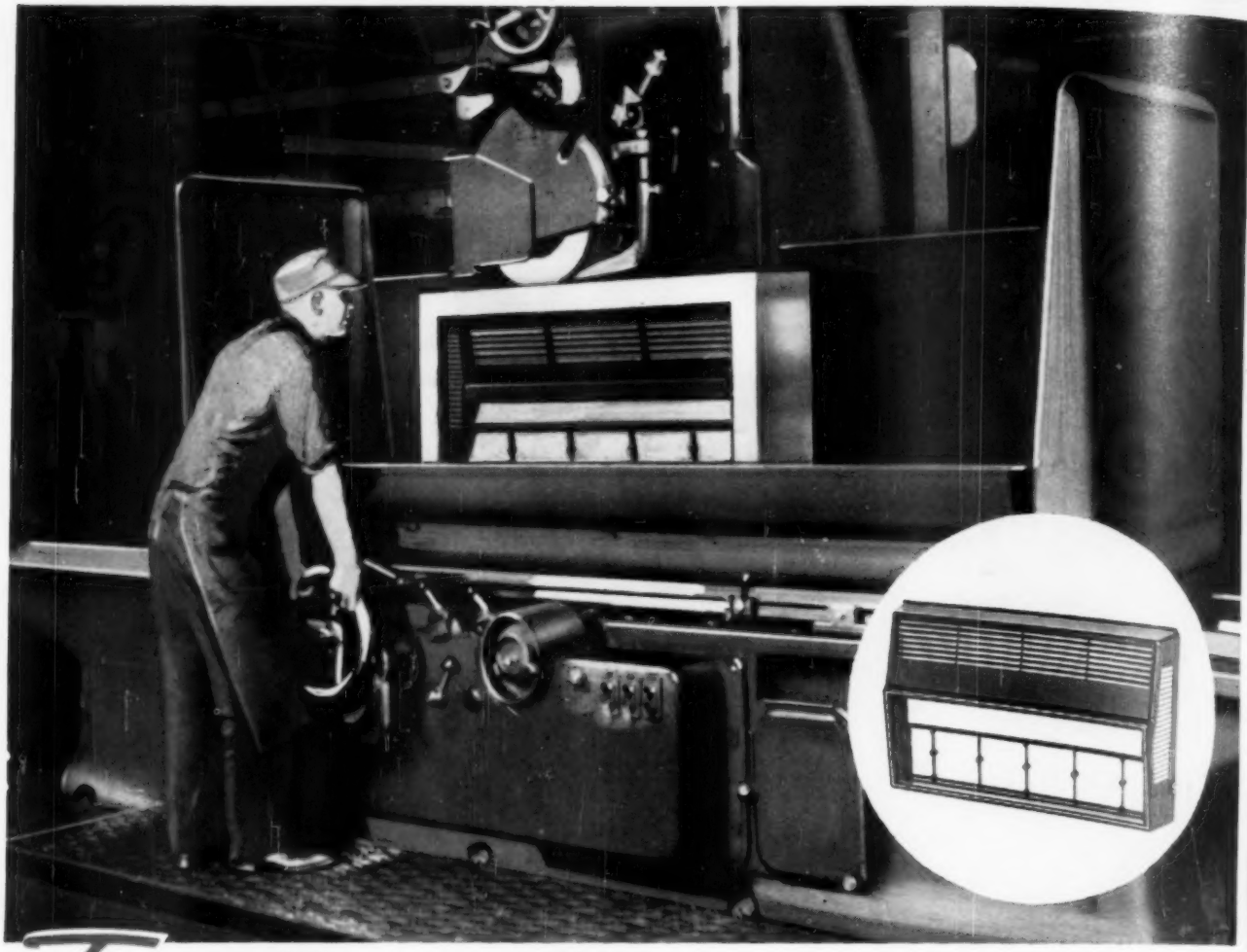


Control panel for 2" extruder completely wired

Compare specifications of any standard Egan Extruder, size for size, with any other extruder.

Standard Sizes (Screw Dia.)—inches	2	2½	3½	4½	6	8
Effective Screw Length—inches	32	40	56	72	96	128
No. Cylinder Sections	1	1	1	1	2	2
Zones of Heating on Cylinder	2	2	3	4	4	4
Maximum Heating Load, KW	12	18	30	48	96	160
Thrust Bearing Capacity, 1000 lbs. @ 50 rpm.	60.5	60.5	119.5	208	288	420
Type Speed Transmission	Worm gear.	Worm gear.	Herr' bone	Herr' bone	Herr' bone	Herr' bone
Usual Motor Size, H. P.	7½-10	10-15	20-30	40-50	50-75	75-150
Approx. Extrusion Capacity lb./hr.	20-50	40-90	75-200	150-450	250-650	450-1200
Approx. Floor Dimensions—inches	40x98	48x112	60x120	84x132	96x156	104x192
Approx. Weight—lbs. (less Drive)	3200	3600	4800	6600	9600	12500

**Extruders are modified to meet requirements for a particular process*



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NDC TRADE MARK

YOUR NATIONAL OFFICE

"The objects of the Society shall be to promote in all lawful ways the Arts, Sciences and Engineering Practices and Standards connected with the utilization of plastics."

THREE NEW SECTIONS!

At the meeting of your National Council, January 18, in Atlantic City, New Jersey, the petitions for three new sections of the Society were accepted and Charters granted to **Central Indiana** meeting in Indianapolis; **Kansas City** with headquarters in Kansas City, Mo.; and **Pacific Northwest** extending into Western Canada but with its center in Seattle, Washington. Congratulations!

Total Number of active sections—32!

NEW YORK SECTION THE LARGEST

As of December 31, 1954 the New York Section had the largest number of members of any section of the Society. In twelve short months, New York moved ahead of Newark, now in second place, and outdistanced Chicago, now third. New York attributes much of this successful growth to the organization and work of a dynamic gentleman, Mr. Guy Martinelli, New York Membership Chairman.

During 1954, 961 applications for membership in the Society were received! Members in good standing totaled 3,241 on December 31, a 25% net increase—thanks to all the Section Membership Chairmen and the excellent work of Mr. Joseph Healey, National Membership Chairman.

PROFESSIONAL ACTIVITIES

At the Annual Business Meeting of the Society on January 20, 1955, Don Hoffman, Administrator of Professional Activities announced a three year program. The six regional committee organization will continue. These are as follows:

Area #1
(a) Connecticut Section
(b) Eastern New England Section
(c) Rhode Island & SE Mass. Section
(d) Western New England Section

Area #2
(a) Buffalo Section
(b) Rochester Section
(c) Northwestern Pa. Section
(d) Ontario Section
(e) Quebec Section

Area #3
(a) Newark Section
(b) New York Section
(c) Philadelphia Section
(d) Baltimore-Washington Section
(e) Southern Section

Area #4
(a) Cleveland-Akron Section
(b) Miami Valley Section
(c) Central Ohio Section
(d) Toledo Section
(e) Pittsburgh Section
(f) Southeastern Ohio Section
(g) Detroit Section

Area #5
(a) Chicago Section
(b) St. Louis Section
(c) Upper Midwest Section
(d) Northern Indiana Section
(e) Milwaukee Section
(f) Central Indiana Section
(g) Kansas City Section

Area #6
(a) New Orleans Group
(b) South Texas Section
(c) Golden Gate Section
(d) Southern California Section
(e) North Texas Group
(f) Pacific Northwest Section

Chairmen for each area are being appointed and their names will be published in the April issue of the JOURNAL. These Chairmen will act as a steering committee and will select qualified members of the Society to accomplish the required tasks. Written monthly reports will be made to each area Chairman.

ACTION!

The major project to be undertaken is the preparation and publication of a series of engineering volumes on plastics.

There are several other projects on which work has already begun. These are:

"Quality Control"—Chairman — L. M. Debing, Springfield, Mass.

"Dynamics of Flow of Injection or Extrusion"—Requested by the Philadelphia Section

"Official & Legal Status as Registered Plastics Engineers" — Harold A. Levey — New Orleans, La.; Richard J. Francis — Newark, Ohio

"Water Absorption Test of Phenolics" — Dr. John Deupres, University of Detroit

Eventually this material will be incorporated in the engineering volumes. **Watch for the monthly progress reports on Professional Activities in the SPE JOURNAL.**

CONFERENCE PAPERS AVAILABLE

The Society has published the technical proceeding of our recent Eleventh Annual Conference in a bound volume, 530 pages in length, with charts and illustrations. Here is an opportunity for those who were unable to attend the Conference to benefit from much of the information presented at it. Request your copy on the order form inside the cover of this issue of the JOURNAL. **Supply is limited!**

WANTED

Plastic manufacturing action shots for framing and display in the National Offices of the Society. Send to

Society of Plastics Engineers, Inc.
34 East Putnam Avenue
Greenwich, Connecticut

Many thanks!

(Please turn to page 37)

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Two Award Winners

Retiring Newark section president (holding award) Joe Bonanno is presented with a plaque by Ed Rowan for his outstanding contributions to the section. New president W. Willert is visible just behind Mr. Bonanno. Presentation was at the Christmas party.

Thomas E. Orr Award

Martin Warner, one of the winners of the annual T. E. Orr Memorial Award, is pictured above. The award is given each year to two college students by the Cleveland-Akron section in memory of Tom Orr, past national SPE president. The award is a junior membership in SPE.

Martin Warren was born in Cleveland and attended public school there. He entered Case Tech in 1950 and was graduated in June 1954 with the degree of Bachelor of Science in Chemical Engineering. As an undergraduate, he was a member of the varsity tennis team winning 4 athletic letters in that sport. He is also a member of A.I.Ch.E., A.C.S., Alpha Chi Sigma, and Tau Beta Pi.

He is now 22 years old and currently a graduate assistant at Case while working for a Master's degree in chemical engineering which he expects to obtain in February, 1956. Afterwards, he hopes to be able to do research and development work in the field of plastic resins.

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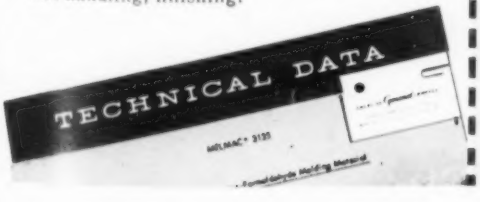
— including properties, test data, information on molding, shrinkage range, preforming and preheating, storage and handling, finishing.



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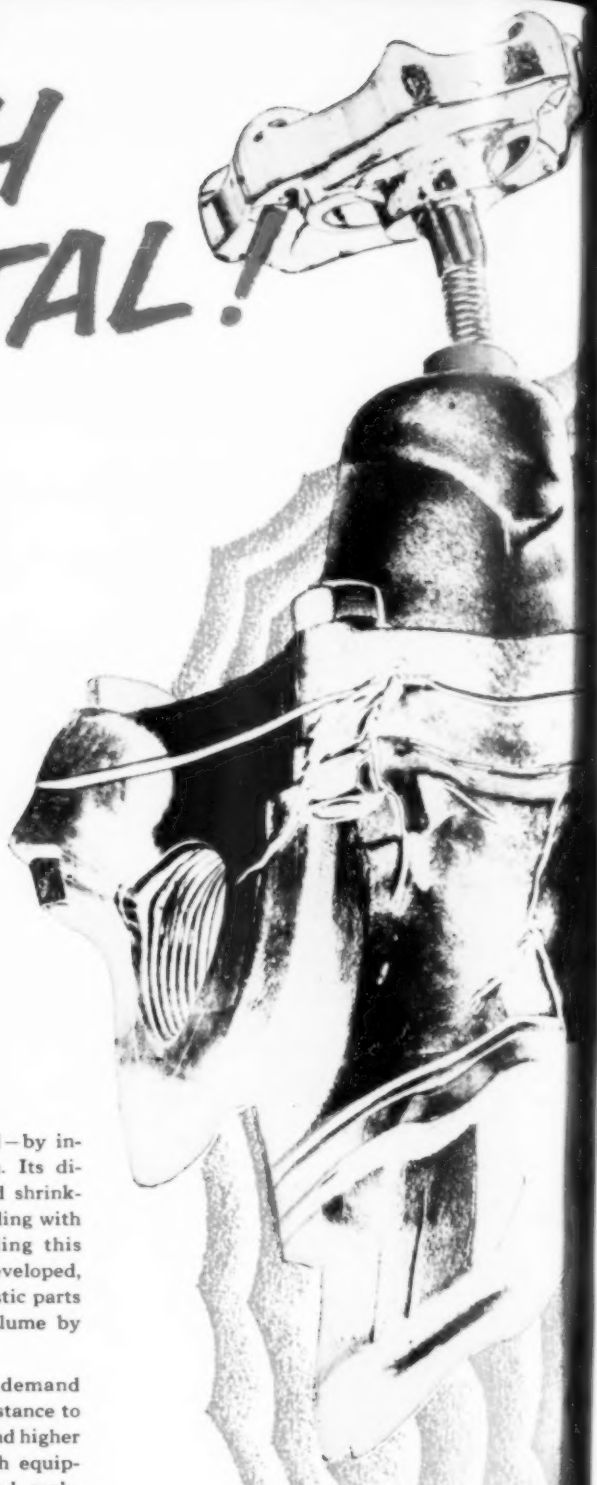

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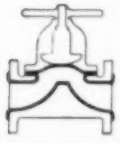

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The non-adhesive properties of KEL-F Plastic are advantageous in the handling of viscous fluids, and in maintaining clean, unclogged lines and equipment.

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Modern processing methods demand plant equipment with greater resistance to corrosion, temperature extremes and higher pressures. The weak links in such equipment are the valves, gaskets and seals. KEL-F Plastic is providing the solution to many of these problems, and producing demonstrable results in reduced downtime and lowered maintenance costs. It is available as a molding compound, or it can be obtained in rods, tubing, sheets and film from a number of suppliers. It is also available in dispersions, suitable for bake-coating on metals and certain non-metals. The full story of KEL-F Polymer should be in your active file. Write us.

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The PLASTICS ENGINEER

spe's education committee defines "plastics engineer" and plans for the future's supply . . .

Jules Lindau, III

President of Southern Plastics, and
Professor of Mechanical Engineering, University of North Carolina

It is the purpose of the Education Committee:

(1) To develop engineers for membership,

(2) To advise and assist our sections in creating programs for additional advancement and interest in our field,

(3) To offer information guiding members in development of this industry to its peak of efficiency in material utilizations for the improvement in health and welfare of mankind, and

(4) To assist in creating curricula at educational institutions that would lead to the development of technologists for our industry.

THE PROSPECTIVE ENGINEER

Through parents and teachers knowledge of the industry can be given to the embryo engineer. At least the influence that will lead toward the decision to enter our field of interest can be assisted by the influence of early study and environment.

It is within the power of our organization to assist in directing those future citizens toward the field of plastics utilization whether it is in material production, application of materials to manufactured articles and processes or solely the use of the end products produced by the first groups.

A program has been suggested by your Education Committee to the individual sections that should be successful in arousing committee interest in our industry as well as recruiting personnel in technical branches. This program included the offering of speakers well versed in our field who could talk to PTA meetings and graduating high school students, as well as freshman and sophomore groups at institutions of higher learning.

The Education Committee is collecting information concerning the availability of slides, moving pictures and other visual aids that will be useful in creating programs of interest for selected groups whom we believe would be recruits to our field of activity. There is in preparation a selection of our aids for the variety of fields which might be chosen by the prospective entrants to our field, the field of plastics.

It is our idea to give all prospective members of the producing family an opportunity for obtaining information in every echelon of production. We would have programs for the variety of categories of technicians, as well as those who would go into other phases of the industry. Additional material could be secured for individuals best suited for creative activity.

This is an ambitious program and requires a most active group in each section. It is my opinion that the program depends entirely upon the ambition and activity of the member in charge of educational activities in each local group. It is not our plan to set up canned programs by specialists for delivery by local sections. We feel that the individual can make the best impression by expressing his opinions in his own words. However, we do feel that there is merit in the suggestions that we offer and we would feel that the work of our committee was appreciated if these programs were carried on aggressively.

To summarize this function of your Education Committee, we believe that it is necessary to make the high school students fully aware of the tremendous area for pioneering that is possible through association with plastic materials. Since our world has shrunken to the point where it is no longer possible to be first in a geographical area that drive for adventure should be directed in the development of new materials and new uses for those materials.

To aid in making the decision firm on the part of our prospective technical leaders, they must be approached with a program that will give specific direction to their curricula. We can make this program point toward our Society. That program should outline the possibilities of individual success in a realistic manner This brings to mind the point that has seriously hampered the development of our industry. That is the glamour and supposed extreme versatility of materials that we have worked out. Just as we should not oversell our industry by making claims for early wealth and success. However, we all recognize that the field of plastics enigneering has wonderful areas for interesting and rewarding progress.

COURSES IN PLASTICS

Our activities in the consideration of courses and curricula have lead to the following thoughts:

The individual whom we are most hopeful of securing in our societey is that technically **skilled and able** personality who has received a degree in engineering or science, but is anxious to continue his education in a more select and, to him, most interesting field. He is the future leader, who, after additional specialized education and experience could be given the title, Plastics Engineer, without fearing that there was something lacking in his background.

In the past we have accomplished a considerable amount of research in curricula that were being offered at

various institutions of higher learning that would be of interest to our future members. Although we are not offering a report at this meeting, it is felt that the work should continue and that it should be published in the future for distribution to our members and be available for distribution by local sections to interested students for information concerning the availability of courses necessary to our field of engineering. Dr. Winding has carried on this activity.

Latest data indicates that more than 71 institutions do offer courses on subjects of importance directly related to the plastics industry. This is indeed an indication that allows us to have an optimistic view of obtaining the courses we feel are necessary.

Demands of our sphere of interest will accelerate the growth of course-offerings and teaching facilities at qualified technological institutions. To indicate the extent of our needs Mr. Bartlett has developed data through questionnaires selectively circulated. His last evaluation has shown a conservative need for 2500 **trained** engineers with a smaller number required each year. These would include those needed for growth for new organizations and for replacements of men no longer available to the industry.

The American Society for Engineering Education has 272 institutional members. They could easily supply the present shortage if we demanded through our need that they do so.

Remember, there are courses in our field in only seventy-one of them. Of those my judgment considers only one actually preparing PLASTICS ENGINEERS, who are capable of acting under that title immediately after graduation.

Now we arrive at the most controversial question that can be placed before any group of educators or members of a professional engineering society — "Is it possible to grant a degree in Plastics Engineering in a four year curriculum that would be of maximum value to the possessor and our industry?"

In considering the standards of that institution, Princeton, as those that would suit the industry, as well as the individual best, in activities in plastics technology, we must recognize the gravity of attempting to compress an already crowded curriculum with the necessary additions to make that most specialized individual, the Plastics Engineer, capable of valuable assistance in a four year study course.

I refer to the interim report of the Committee on Evaluation of Engineering Education, that has been sponsored by the American Society for Engineering Education. They have developed an experimental time distribution in scientifically oriented engineering curricula. It is broken into four blocks totaling 100 semester hours on the basis of a common stem.

Those blocks include:

1. Humanities social,	21	semester hours
2. Math and basic science in equal weight,	36	" "
3. Engineering science,	36	" "
4. Required technology,	7	" "
Total for the common stem	100	" "

The remainder of the curriculum includes the following blocks:

5. Major departmental sequence of engineering analysis design and systems,	21	semester hours
6. Options or electives in the following categories: Humanistic-social, management, basic science, engineering science, research or thesis, engineering analysis or design and technology,	17	semester hours
Total for four year curriculum,	138	" "

In the basic sciences for example they recognize that it will be necessary in physics to give sufficient information to allow those new concepts including nuclear and solid state physics to be understood by the undergraduate engineering student. Chemistry must include inorganic, organic and physical branches in general form, plus a working knowledge of physical chemistry for all engineering students.

Under the field of engineering sciences we recognize that there is duplication between the classical sciences and subsequent engineering sciences. This is the useful purpose of achieving recognized pedagogical values in repetition.

These sciences include nine elements in the assisting curricula.

They are: statics, dynamics, strength of materials, fluid mechanics, thermodynamics; electrical circuits, fields and electronics; heat transfer, engineering materials and physical metallurgy.

In my opinion a course in polymeric materials could be added with substantial value to all engineering curricula.

With that short explanation of some requirements for the standard engineering degree we can see where it would be practicially impossible to include sufficient information in curricula that exist at present to prepare a technician in four years for our assistance.

There are four possibilities for making additional room for new additional curricular material. They are:

1. Raise the prerequisites for entrance into technological institutions which would require additional study in high school or preparatory school or greater selectivity of students which would reduce the number of those entering these institutions.
2. Increase the efficiency of institutions.
3. Eliminate some of the material now on the curricula, and
4. Extend the curricula to more than four years.

These four items each allow tremendous room for discussion and each may be effective to some degree. In essence, my opinion is determined by the fact that we want our plastics engineers to have broad training in general engineering along with the narrow specializations of our particular industry. Under the present state of our educational system my only answer would be in the extension of the time devoted to study.

That summarizes an important activity of your Education Committee. However, there are additional activities that your Educational Committee has labored on with considerable interest and we feel definite benefit to our Society.

THE PLASTICS ENGINEER

Among those items has been the adoption of our definition of a Plastics Engineer which we hope may be used in the future by our Society to aid in the selection of membership and to define our sphere of interest. I may add in passing that each of our committee members during the meeting that took place in October, assisted in selection of this definition, but that Dr. Church was the man who proposed the statement a Plastics Engineer is: **"An engineer mainly concerned with the application of problems of engineering and allied sciences to the production or utilization of plastic materials."**

In this definition the word **"engineer"** is defined by its legal definition and the word, **"plastics"** is defined by our industry.

LOCAL SECTION PROJECT

An additional project is the selection of film and program material for use by local sections. Members of our committee have volunteered to develop a group of slides, pictorially illustrating a typical script covering engineering activities in the industry. This script is to be used by local sections if desired, but its primary importance would be to act as an example of the type of material that we feel would be most suitable for local use in engineering development rather than product or sales development.

PLASTICS BIBLIOGRAPHY

Dr. Chapman is engaged in a work that we feel of considerable value and significance to our membership. That is the compilation of a list of textbooks and reference books which we feel are worthy of recommendation on an engineering level.

Each member of the committee has been charged with the obligation of making a list of those books that he feels should be included.

After discussion of these lists we are anticipating the editing, compilation, and, with the assistance of the Society, publication of the list of those texts.

At present we do have a list that has been mimeographed for use by committee members. We would be pleased to give this information to those who are interested, upon request.

RESEARCH SYMPOSIA

Through the efforts of Professor Bryce Maxwell, our Committee Secretary, and Director of our Symposium Sub-Committee, programs of the highest order of scientific progress and industry interest have been selected for our past symposia as well as for the program during this conference.

We take pride in this work and feel that we should all advise Bryce Maxwell of our appreciation for his excellent work.

In fact I feel that if this were the only activity in which your committee was engaged, it alone, would make your committee worth while.

SUMMARY

This seems to be an excellent point on which to conclude the subject of the activities of your Educational Committee. Therefore let me state that we will continue to progress in the direction that has been indicated by this paper: by assisting in the development of program material for a recruiting of students to our field of interest; to aid in the development of curricula for engineering; to establish criteria for membership; to disseminate information concerning availability of courses and literature in subjects of necessity and interest to our members; to give papers of scientific value and to offer suggestions and assistance to the Society as well as individuals in aiding our organization to be the fountainhead of engineering information in plastics.

Trends in the Plastics Industry

Herman Zabel

Roger Williams Technical and Economic Services
New York, New York

BIG BUSINESS

Plastics found their first uses in such small items as the celluloid collar and billiard balls. From these beginnings the industry has moved in an almost continuous surge to its present near three billion pound-a-year status.

Certainly this surge will not be stopped for lack of interest by industry.

One reason for this great interest in the plastics industry is its great size—for chemicals and even more important, its great unrealized growth potential. In such a large industry there are many trends—all of great importance.

Today I believe that the most important trend is the entry of large, well financed industrial organizations into the plastics forming industry. Such entry is occasioned by their ever-present desire to diversify plus the need to be sure that the company may not be missing a good bet. These are the vague general reasons which must eventually be met by black ink in the profit-and-loss statement.

Before pursuing this thought any further let's take a quick look at the plastics forming industry today. Our estimate of the total sales volume of the plastics forming industry is about $2,500,000,000. This sales volume is divided up among some 5,000 individual fabricators. The average sales volume of each fabricator is then approximately $500,000, of which an average of 40% is expended for the plastic. Thus the value added in manufacture is only $300,000. In comparison to similar figures for most other industries this figure is extremely small. In terms of actual investment the average net worth of all plastics molding companies is only one-fourth of the sales volume or $125,000. This figure is the average for the whole molding industry.

But now let us look at the extreme, extrusion. It is possible with a total new capital input of about $10,000 to start a business which is capable, physically, of handling

about $2,000,000 worth of polyethylene plastic. A 20% return on this amount of invested capital is only $2,000 per year—0.1% of the value of the plastic. For the unscrupulous this opens the way for a "quick buck." It does not take much reduction in the thickness of a pipe wall or extra filler to provide an "unscrupulous" return of far more than the probable legitimate profits from such a business. Unfortunately there has been too much of this scrimping on the plastic content and addition of extra filler. In the field I have seen extruded plastic pipe rated at 100 psi burst at a cold water pressure of something under 70 psi at two separate locations on the same line. To my untutored eye there semed to be much more filler than plastic at the break. Complaint to the supplier produced only a curt reply, "Send it back and we will replace it." It is unfortunate that the reputable extruders have to be tarred with the same brush as these unscrupulous individuals.

INVESTMENT CAPITAL

Let's return to the investment ($10,000) to handle $2,000,000 of polyethylene. Is this man in the manufacturing business? No! He is in the warehousing and distribution business. Consequently his profits should be figured as a percentage of sales rather than as a percentage of investment as is the normal practice in the chemical industry. But to return to my pet example, pipe is sold to everybody and practically at all conceivable locations. To meet this latter problem, present pipe suppliers, mostly metal, have had to develop a rather extensive series of warehousing depots, each centered close to a major market center for this commodity. Since these depots are already located at, and are distributing into these major market centers, they are already warehousing pipe and are moving pipe to the local markets. The next question is: Why shouldn't they take over the plastic pipe industry as markets develop? They should and are already doing so. National Tube Company, Republic Steel Company, and the Youngstown Sheet and Tube Company are already producing and selling plastic pipe. Eventually virtually every pipe warehouse in the country will become equipped with an extruder, a set of dies and a relatively small inventory of plastics. Orders will in many cases be extruded after receipt. The small local pipe extruder, of which there are many, will have his troubles meeting this type of competition.

Let's return to the average net worth of the plastics molder, about $125,000. This capitalization is inadequate to allow any major expenditures for research projects which may take months or even years to show a profit. Further, at this investment level, only those research projects which appear to promise immediate payout can be undertaken, else a very major portion of the net worth of the company becomes tied up in completed but unrealized research results—one way to go broke. This need for immediate results on any research undertaken has led to the utilization of Edisonian techniques, efficient for a limited objective but inefficient in the ability to transfer results from one project to another. Perhaps a worse offender in this direction is the Government, particularly in the various research studies on reinforced plastics. Certainly limited capital is no excuse here.

A corollary of this limited capital is that the present plastics molder is not financially capable of carrying on any research program of any magnitude or any research at all. Then where will the expense of research and development come from? First, it must be provided by an aggregation of capital which is capable of taking the long term risk associated with any major developmental program. Second, if research is to be pressed to a successful conclusion it must be carried out by an organization which will get a liberal sprinkling of black ink on their books as a direct result of the study—in addition to recovering the cost of the research. There are three types of organizations which match these two conditions. They are:

1. **The Company manufacturing the plastic raw materials.** This is being done to a greater or lesser degree by all of the plastics manufacturers. For example, one chemical company furnishes instructions for the production of a reinforced plastic water cooling tower. It supplies the raw materials for the resins used in the production of the tower.

2. **The organization assembling and distributing the final product.** An example is the developmental work that refrigerator companies are doing on use of plastics for liners.

3. **Large organizations interested in diversification.** To fall within this classification an organization must have the flair finances and patience required if any large research program is to be successful and profitable. There are a number of large companies which fit this classification.

Success of any of these companies will be governed by their choice of fields of plastics forming. For short run items which can be fabricated on standard equipment, a large company is at a tremendous disadvantage. Too, the small fabricator is in a fairly good competitive position on long run items if he has no particular distribution problem. But in such cases the final assembler often finds it worthwhile to incorporate the plastics forming equipment as a portion of his assembly operation.

THE FORMING BUSINESS

There is still another field where the large aggregations of capital are required. It is in the development of forming techniques for those plastics that are hard to mold. Teflon, and nylon are examples.—Teflon because of the extreme difficulty in forming by almost any other procedure except machining, nylon because of the extremely high fluidity of the polymer during the molding operation.

Finally, I would like to point out how fast plastics forming industry has been growing. Depending on the period referred to, the plastics industry has been expanding at a rate of some 15-20% per year. If the industry expands 20% this next year, use will have to be found for another 560,000,000 pounds of plastic; 672,000,000 additional pounds the following year. Such quantities can only be absorbed by a few large organizations or a multitude of small companies or some combination of them. Usually when there is a big job, a big organization must be called in. Even a 5% expansion necessitates a new market for 140,000,000 pounds of plastic next year.

To absorb such quantities of material, over a half billion pounds per year, plastics must enter into competition with present mass-produced materials—commodities. Other products cannot under any condition provide the indicated poundage. Here again, the need for a large well capitalized organization is apparent to finance the tests and studies needed to engineer the article for most economical production. Such engineering plus the quality control needed to turn out the same product day after day, are also costly.

But usually the field of the large company will stop at the product manufactured at the commodity level. The large company cannot meet the flexibility and versatility of operation of the present plastics molder. It is the old story of high overhead for the large company which is difficult to write off on short run items or items in which there are many changes during the run.

The Pilgrim's Progress in Plastics . . . .

Louis F. Rahm

Director, Plastics Laboratory, Princeton University

INTRODUCTION

At previous annual meetings of the Society you have heard the results of two surveys by the educational Committee. The first of these[1] showed what was being done in plastics engineering education at 35 leading colleges and universities, and indicated that on the whole very little was being done, with only one university operating an educational program such as the Society endorsed several years ago. The detailed results of this survey are of interest in engineering education but by themselves they are not significant since, without other evidence, one might conclude that little is being done because there is no need for such education. The second survey[2] however, gives positive meaning to the first, showing that 98% of the industrial organizations polled need men with the training proposed by S.P.E. and than an equal 98% resort to on-the-job training because they cannot find men specifically trained in this field. Further, this survey indicates the major occupational fields to which industry would assign such plastics engineers if they were generally available. For the purpose of this discussion this second survey has been used for a direct comparison between what industry believes it would do, and what it actually is doing with such plastics engineers, in occupational placement.

Before looking at these results it may be well to consider for a moment who this individual is, under discussion. On the one hand the Educational Committee has recently given us a rational definition of the plastics engineer. He is, **"An engineer mainly concerned with the application of the principles of engineering and allied science, to the production or utilization of plastics materials."**

You may note that this reasonable statement recognizes the status of all those engineers in the industry who, although not specifically trained for it, have learned the hard way and have developed their special abilities in plastics, as needed. It would be interesting to know more about these rugged individuals who have engineered the industry to its present success, but no figures are available at this time to indicate either the background or the occupational distribution of this group. In consequence the present discussion is limited to a consideration of those young men in the industry specifically educated for the purpose, and whose careers are known.

These are certainly unusual fellows who, having four years of chemistry, chemical, mechanical, or electrical engineering have topped this off with two years of graduate specialization in plastics. These boys each have, under a single skull, a good general knowledge of the industry from raw materials to management, including the technology of industrial operations, high polymer chemistry, the chemical engineering of plastics, product engineering and tool design, theory and application of dielectrics, and the science and mechanical engineering of plastics,—all this with a generous first-hand experience with research in this field. This is the product of the S.P.E. educational program and it is interesting to observe how such talent has actually been assigned in industry.

Referring to the chart it may be seen that the plastics engineers have been classified according to their original undergraduate fields of interest since this would normally have a bearing on the general occupational fields in which they might work in plastics. The occupational classification is well defined except for "Miscellaneous" which includes management and "everything else." The figures in the upper left of each block represent the percentage distribution which industry would make of the plastics engineers it needs. The figures in the lower right of each block represent the corresponding actual distribution of plastics-trained engineers whose industrial histories have been followed.

OCCUPATIONAL CLASSIFICATION

Since these results were not predictable in advance it was rather surprising in the first place to find such good general agreement in the totals of occupational classification. The actual distribution corresponds almost precisely with the industrial estimate for plastics engineers in general or the "average" plastics engineer. This is the more surprising in view of the great variation under some classifications.

Thus for the "die-hards" in the teaching profession who have long believed that the industry was weakest in "Development and Design" there is considerable satis-

Industry's Use of Engineers

CODE: IND EST — %; ACT PLA. —

	RESEARCH	DEVELOP. DESIGN	PRODUCT	TECH SERV. SALES	MISCEL
MECH ENG	4 / 30	49 / 46	21 / 8	14 / 8	12 / 8
ELECT ENG	8 / 11	47 / 45	9 / 11	19 / 11	17 / 22
CHEM ENG	16 / 10	35 / 43	24 / 19	11 / 14	14 / 14
CHEMIST	40 / 28	41 / 44	8 / 14	8 / 14	3 / 0
TOTAL	17 / 18	42 / 44	17 / 14	13 / 12	11 / 12

(1) *Prof. C. C. Winding, Cornell University*
(2) *R. C. Bartlett, Natvar Corporation*

faction in the industrial estimates which indicate it, and also in the fact that our educational product is actually being placed where it is most needed. One might expect the mechanical engineer to be used even more for this work than either figure indicates, and the chemist less. Since in actual placement this classification almost completely represents product development, product design and mechanical process development rather than resin development or chemical engineering processes, it is therefore surprising that the chemical engineer and chemist even exceed the industrial estimates in this category. The chemical engineers have always indicated a strong preference for "Development" rather than "Research" and this can account for the discrepancies in these figures.

Under "Research" we find the greatest imbalance with the very low industrial estimate of 4% for the mechanical engineer. This may be explained in part at least by the past unrewarding efforts of mechanical engineers in basic mechanical studies of plastics materials. The average mechanical engineering B.Sc. simply does not have sufficient background in solid-state physics to do original work in the investigation of such materials and this may be recognized by industry. Furthermore, industry may consider this a prior field for physicists and prefer to use the mechanical engineer in more customary capacities. That 30% are actually engaged in this work indicates at least that the mechanical plastics engineer is capable of doing a type of work not commonly done by engineers before. However, it may be hoped that industry will in time scale up its estimate of mechanical research even though the percentage of men actually so employed may decline to a smaller figure than shown here. The other research figures are not so seriously out of line as these, but still show sizeable discrepancies such as the light placement of 10% for chemical engineers previously noted. Also the chemistry research appears surprisingly light at 28% but it should be remembered that the chemists concerned have slipped the leash, so to speak, and have taken two years of graduate training in engineering, probably indicating that they did not want to make a life work of chemistry in the first place. This combination training most probably also accounts for the 44% in "Development and Design" where straight chemists would not be expected in such a concentration.

DISTRIBUTION IN PRODUCTION

The distribution in "Production" is not consistent and the actual placement of mechanical engineers is surprisingly low. One explanation may be that graduate training is not so essential in this field and that graduate engineers probably find this occupation less interesting than others. At the other extreme the plastics engineering chemist is doing more in production than would be expected, probably because of the combination training which prepares him better for this field than would straight chemistry. The chemical-engineering production figures are out of balance in the other direction, but in both cases these is more than meets the eye in this comparison. One would expect the industrial estimates for chemical engineering and chemistry to concern mainly resin production. However, the actual placements have been in conversion or fabricating operations with practically none of these men interested in straight chemical engineering production,—the more surprising since over one-half of all the men in this survey had been chemists or chemical engineers before their graduate training.

In regard to "Technical Service and Sales" it may be seen that the mechanical and electrical men are actually not used as much as was estimated for this service, while the chemist and chemical engineer are out of balance in the other direction. Since a large part of this service concerns intimate knowledge of materials properties rather than technological processing, industry may have assumed that the chemist and chemical engineer are basically better equipped for these particular actual assignments. However, it is reasonable to believe that the original industrial estimate indicates a better distribution than the actual placement figures and that these in time will show better correspondence, since the mechanical and electrical engineers we are considering here are even better equipped than chemists and chemical engineers for certain fields of technical service. Since this is an excellent field for acquiring valuable experience we cannot account for the low actual placement figures for the mechanical and electrical men.

The category "Miscellaneous" is of course the wastebasket of the occupational classification. One cannot be sure what industry had in mind under this heading beyond those restless souls with an uncontrollable impulse to try one hand at least in the hot water of management and administration. In this category the chemist seems to have been unnecessarily discriminated against both in estimate and in actual assignment where he has been blanked-out entirely! The electrical engineer at 17% provides the greatest discrepancy in the general pattern but the 22% is an even greater anomaly. On the one hand the 22% is known to include some teaching which would not have been considered in an industrial estimate, but which has actually happened. Further, although industry would not be assigning company presidencies to eager young plastics engineers, nevertheless there are two in the 22%, both however involving engineering work.

One or two case histories, illustrating the pilgrim's progress in plastics may be of interest to you, and for this purpose these people will be X and Y. Any resemblance to characters or companies, living or dead, is sheer coincidence.

Joe X finished his training in 1949 and launched his career in the transportation industry through the plastics section of a materials research and development laboratory. At a starting salary then about $500 per month management probably considered Joe plainly a bandit at the outset. However, he quietly went to work on a succession of ever-present materials development problems involving bonding resins, electrical insulation and mechanical components, delivering results and full value almost immediately. This work was interesting so long as new projects developed but at the end of two years Joe decided that he would have better opportunities in an organization in which plastics were a primary concern. About this time the A.B.C. Company decided to enter the field of plastics materials production and began to recruit a technical staff. And now for the needle in the haystack,—where, without plundering a competitor, would one find a man competent to set up and supervise a testing laboratory, a materials and product development group and advise on production problems? Fortunately Joe and A.B.C. got together and three years later it may now be reported that both the doctor and the patient have done well from the beginning. Joe now has considerable responsibility in the various fields of evaluation, development and production and if in the meantime his income has increased to $800 per month this appears to be reasonable evidence that his company feels that he is worth it. A.B.C. knows quite well that no young man without Joe's training could have so easily and effectively matched up to his responsibilities in so short a time. It has taken others years to do it the hard way.

(Please turn to page 37)

Plastics Is . . .

. . . As Plastics Does

Elmer F. Schumacher

Director of Sales, Polychemicals Dept., E. I. DuPont de Nemours and Co., Inc.

PLASTICS—UGH!

Some months ago while being entertained at dinner I admired the hostess's new container for catsup, shaped and colored like a luscious ripe tomato. Without any prompting on my part she assured me it was not plastic, it was something better.

Just four weeks ago, while shopping at Wanamaker's my wife was attracted by what looked like a good buy in kitchen tools. She talked to the sales lady about it, who informed my wife that, in her opinion, the set was not a good buy because the handles were plastic. She suggested instead that my wife buy another set where the handles were Bakelite.

Is this typical?

A few months ago Alfred Politz Research, Inc., who does market research for us, examined the prospects in a certain market for our "Zytel" nylon. They asked a lot of what I believe are very intelligent and searching questions and found that plastics as a class were held in very low esteem. But, this same market thought very well of nylon. Now whether this market thought well of nylon because of familiarity with women's stockings or because they were ignorant of it as a plastic is beside the point. The point is that the market did not think well of plastics.

Let's look at some of the conditions that prevailed during this period of plastics' most rapid growth, after World War II:

We were in a sellers' market, a period when the pressure to produce was great.

One could literally sell anything, or maybe it would be better to say that the public would buy most anything. Price was apparently no particular object, so profits tended to be high.

It is true, too, that one could get into plastics processing with a relatively small investment. (And I don't mean by that to belittle the processors—to the contrary.) A study in '51 showed 78 per cent of the processors with less than 200 employees.

It seems inevitable that, under such conditions, there would be mistakes and a great many wrong applications of plastic materials.

THE COMPETITIVE MARKET

Now we are in a competitive market—a highly competitive market. The mistakes that were so easy to make during the lush years of the sellers' market have come home to roost in the form of diminshed public esteem.

Not only that—our troubles are augmented by new mistakes growing out of the present competitive situation. Such mistakes as skimping on the quantity of material in a dish, a household utensil, film, or what-have-you, are compounded by instances of outright copying of design. The regrettable frequency of these practices indicates the absolute need for somehow getting the industry back on a quality basis.

All of this has given many segments of the industry a great deal of concern, and no group has had greater concern than the Plastics Materials Committee of MCA.

The group has discussed the prestige problem many times and approached it from many angles. They have considered, for instance, retaining public relations counsel and instituting a public relations campaign. More mature consideration made this, however, seem unwise at this time for the simple reason that it is useless, indeed unethical, to tell the public how good you are unless you really are good. Certainly no public relations expert worthy of the name would undertake a campaign unless the industry as a whole lived up to what that industry wants the public relations expert to say about it.

STATEMENT OF PRINCIPLES

At one meeting about a year and a half ago, the Plastics Materials Committee of the MCA was considering this matter of industry prestige. This discussion indicated that there was a need to set down some guide against which one might judge whether a project was for the good of the industry, and a Sub-Committee was appointed for that purpose. It was also suggested that the Committee might come up with some ideas as to what might be done about the prestige problem. The "Statement of Principles by the Plastics Industry" grew out of that activity.

As a member of that Sub-Committee and one of the authors of the Statement of Principles, I would like to review the Statement in some detail to see if we do not all agree that it does say what we want the industry to be and do.

"Plastic materials challenge industry with new concepts of design, engineering, construction, processibility and usefulness." Would anyone disagree with that? Many wonderful things have been done with plastic materials, and I am certain that many, many more are yet to be done.

"The properties of plastic materials, when correctly used, open up great new areas of service to industry and the public." This statement is really corollary to the first and needs no further amplification.

Conversely, "Improper use can do irreparable damage to the plastics industry, to both manufacturers and processors of the materials." The Chicago Tribune on August 5, 1953, published a modification of their editorial of July 7, 1953, "Plastics—Phooey," which got such wide circulation. But it seems to me we might as well be honest with ourselves and realize that those kinds of stories are like dropping a stone in a pond, the ripples go on and on. They do damage that can be repaired only at the cost of great expense and effort.

Again from the Statement:

"Therefore, we as manufacturers and processors of plastic materials reaffirm our adherence to the principles upon which the healthy growth of a great industry depends."

We are saying here that we "reaffirm our adherence to" certain principles. We are saying that we recognize and deeply respect the sound manufacturing and merchandising principles on which healthy growth depends. If we hold these principles in high esteem, let's be awfully sure that we continue to practice them.

PLASTICS LIMITATIONS

The Statement goes on to say that we "undertake to: I. Understand thoroughly the properties and limitations of all plastic materials handled by us." Very simple, you say, indeed axiomatic. But is it?

As a rule we tend to treat lightly the limitations of our materials. People generally, housewives included, pretty well know the limitations of glass, that it is brittle and will cut if broken; steel and iron, they know tend to rust if not taken care of; they know the limitations of wood, that it splinters, swells when wet, and they have what amounts to an inxate tendency to correct for the deficiencies of these traditional materials. I think it is fair to say that they do not know plastic materials at all in the way they know these traditional materials, and with the great variety in plastic materials, we in this industry have simply an enormous problem of educating public and industry so they do have comparable understanding.

We have to give a lot of thought to complete, informative labeling, giving detailed information as to how to use and handle products made of our materials but being quite explicit, I think, in saying what may not be done with them. There is in this situation, incidentally, a great challenge to design. I have no doubt that we can by good designing overcome or compensate for some of the deficiencies in our materials, or by skillful designing of end use products render the deficiencies unimportant.

This last thought is set forth in the second and third undertakings mentioned in the Statement: "Apply the correct plastic materials to all **industrial** end uses, designing and engineering them for maximum value, performance and safety." The third one, "Use great care to select the correct plastic materials for all **consumer** items, designing and engineering them to insure value, satisfaction, safety and pleasure to all users."

These last two quoted undertakings are in reality the heart of the whole problem we are discussing.

SELL PLASTICS ON REAL MERIT

The fourth undertaking mentioned in the Statement of Principles is "Sell plastic materials, and all industrial and consumer items made therefrom, on the merits of the materials, applications and design, and free of extravagant, insupportable claims." This has been said many times by many people in our industry, but it needs to be said again and again, and yet again. And here let me go back to what I was saying about the public relations man and add this thought—that a public relations campaign is no substitute for merit. We will have to earn good public relations.

The Statement of Principles closes with the thought, "All to the end that plastic materials already available, and others that may come, will bring to industry and public alike all the benefits, economies and satisfactions inherent in these versatile engineering and construction materials." Again, I am sure no one of us will quarrel with that statement. It represents the consummation of all our hopes and wishes.

Now, it is very easy in a talk of this kind to convey the impression that nothing is right in our industry. That we are doing no good. That is neither my opinion nor my intention. We have accomplished a great deal, but the applications of our materials are infinite and the potential in this business is so great that the prestige problem I have discussed does seem to be not only fundamentally important, but very pressing.

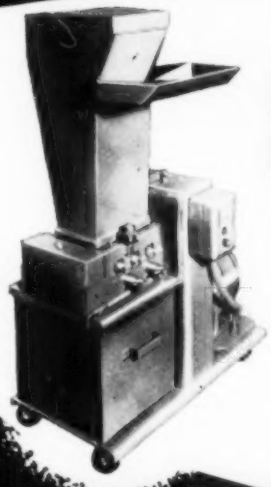
Well, we have a Statement of Principles. What do we do with it? How do we implement it? The Committee that drew up the Statement was often asked what kind of enforcing agency was contemplated. The answer is—none. For one thing, it's just plain illegal to try to control or police all the elements that make up our industry, and impossible, if it were legal.

A WAY OF LIFE

If these are indeed "the principles upon which the healthy growth of a great industry depends," and a great many have said so, then I say to you, they must become a way of life.

This Statement of Principles now bears the signatures of five associations active in this industry: your own organization, SPE; the MCA; SPI, Plastics Coatings and Film Association, and Proprietary Plastics Manufacturers Association. Eight hundred and eight-six different companies, 33 of them in Canada, and 25 abroad, have endorsed this Statement by adding their corporate signatures.

The members of this fine organization, engineers dedicated to the advancement of sound development and design, are in key positions to most effectively promote "the principles upon which the healthy growth of a great industry depend" and I commend the principles and the industry to your care.

Economy-Minded Molders
Use the NEW
IMS

ELASTOMERIC GRANULATOR
for all vinyl, polyethlene and hot sprue grinding
New Slicing Action
Cuts Soft Plastics
Without Fluffing
Only 2 Minutes to Clean!
Quiet, Safe, Compact
ENDS THROWBACK
Order NOW:
Price Complete, with 2 HP Motor . . $698.50
INJECTION MOLDERS SUPPLY CO.
3514 LEE ROAD WYoming 1-1424 CLEVELAND 20, OHIO

STATISTICAL CORRELATION . . .

—a solution to plastics molding problems—

Harold Gulde

Minneapolis-Honeywell Regulator Co.

When trouble plagues a molding process, the first step is to find out which variable is causing the trouble. Statistical correlation is an important tool in finding the trouble-causing factor.

This article is the seventh in the series "Statistical Quality Control for the Plastics Molder" written by the S. Q. C. committee of SPE under the chairmanship of L. M. Debing.

The molding process has hundreds of variables which affect the molded part. A few of these variables can be controlled, namely, length of preheat, transfer pressure, temperature of preheat, weight of preform, and the like. However, many variables must necessarily be left to vary at will during the molding process. Whenever trouble is experienced in molding a part, it is necessary to find which variable is causing the trouble.

Correlation is a technique which can aid in the search for the troublesome variable. It measures the degree of association between two variables. If a change in one variable causes a change in another variable, then the two variables are correlated. The more closely the two vary together, the greater the correlation. The variable which produces an effect on a second variable is called the independent variable. The second variable, i.e., the one affected, is the dependent variable. For example, length of preheat affects transfer time. Length of preheat would be the independent variable, and the transfer time would be the dependent variable.

Correlation should be used to correct processes rather than for day to day trouble shooting. It takes too long a time to perform to find ordinary operator trouble. However, its principles may be applied even if the actual measure of correlation is not made.

There are several requirements necessary for data to be used to determine the degree of correlation.

1. Both variables which are being correlated must be measurable, i.e., we need quantitative values for both variables.
2. If possible, data should be obtained over the entire range of values of the independent variable in which there is interest.
3. If linear correlation is to be employed, the variables should plot as an approximate straight line. Methods somewhat more complex than those of this article are required where a linear plot does not apply. (Ref. 1, Chapt. IX). The data are usually plotted as in the example below to judge this point.

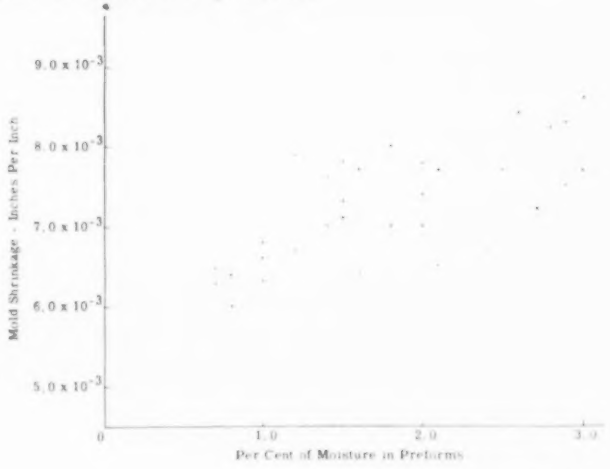
An example showing the effect of moisture in the preform on mold shrinkage of one type of molding powder will be illustrated. Data were collected on the mold shrinkage of parts made from preforms of known per cent moisture. In any correlation problem the data are always collected in pairs; for each known value of the independent variable, a value is obtained on the dependent variable. In the following table, the per cent moisture in the prefrom is the independent variable and these are listed in the column headed "X". The dependent variable, mold shrinkage in inches per inch, is listed in the column headed "Y".

Table I—Original Data—Per Cent Moisture In Preform vs. Mold Shrinkage

x	y	x	y
.7%	.0063	1.8%	.0070
.7%	.0065	1.8%	.0080
.8%	.0064	2.0%	.0078
.8%	.0060	2.0%	.0070
1.0%	.0066	2.0%	.0073
1.0%	.0068	2.1%	.0077
1.0%	.0063	2.1%	.0065
1.2%	.0079	2.4%	.0067
1.2%	.0067	2.5%	.0077
1.4%	.0076	2.6%	.0084
1.4%	.0070	2.8%	.0082
1.5%	.0071	2.9%	.0075
1.5%	.0078	2.9%	.0083
1.5%	.0073	3.0%	.0077
1.6%	.0064	3.0%	.0086
1.6%	.0075		

Data of this sort lend themselves conveniently, and informatively, to plotting on a scatter diagram as shown in Figure 1. Values of the independent variable (moisture in preform) are measured along the horizontal scale, and values of the dependent variable (mold shrinkage) along the vertical scale. Each pair of values plots as a point on the scatter diagram.

Figure 1.—Scatter diagram of mold shrinkage vs. percent of moisture in preforms.



A good deal of information can be obtained from the scatter diagram. Figures 2 through 8 illustrate some typical situations. If the points plot as in Figure 2, we have positive correlation. In this figure as one variable increases the other also increases. Figure 3 shows negative correlation. As one variable increases the other decreases. Figures 4, 5, and 6 show examples of no correlation. Figure 7 is an example of very high correlation. The two variables are correlated, but not to a high degree, on Figure 8.

In the scatter diagram of our example we have fairly high positive correlation. Also, the data plot approximately as a straight line. This is one of the conditions mentioned as necessary for the simple correlation of two variables. The scatter diagram gives a visual picture of the data on the two variables.

At this point, we return to the original data to calculate three important measures of the correlation.

(1) The correlation coefficient, which is a measure of the amount of correlation between the two variables.
(2) The line of best fit, which, in this case, is the best line for predicting mold shrinkage from moisture content, and
(3) The 95% confidence limits of this prediction.

The correlation coefficient may be defined as:

$$r = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{N}}{[\Sigma x^2 - (\Sigma x)^2/N]^{1/2} \quad [\Sigma y^2 - (\Sigma y)^2/N]^{1/2}}$$

Scatter Diagrams Showing Degrees of Positive and Negative Correlation

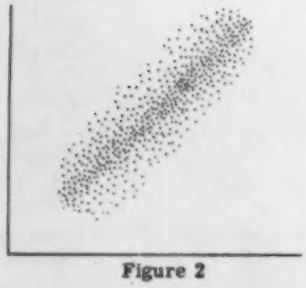


Figure 2

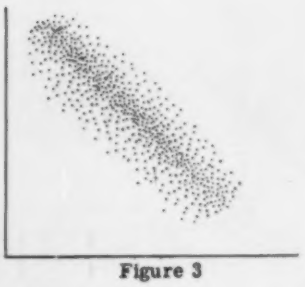


Figure 3

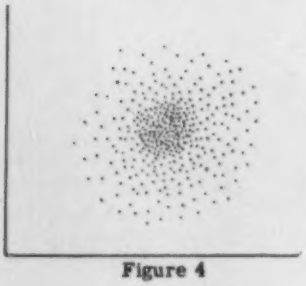


Figure 4

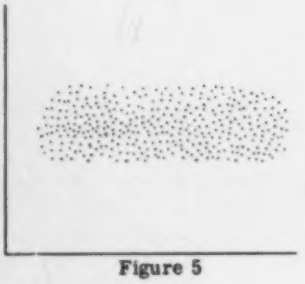


Figure 5

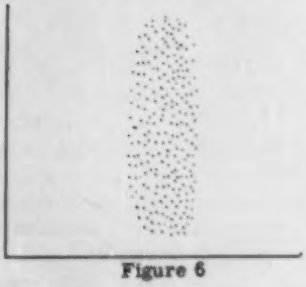


Figure 6

Figure 7

Where **x** represents values of the independent variable,
y represents values of the dependent variable,
N represents the number of pairs,
Σ sign means the sum of all the values, i.e.,
Σx means the sum of the x values.

The calculation of **r** is not as difficult as it would appear if the several steps are carried through in the systematic procedure shown in Table II. These same calculations also provide the solution to the line of best fit and to estimating the 95% confidence limits.

Table II—Setup for the Calculation of the Correlation Coefficient

x	y	x^2	y^2	xy
.007	.0063	.000049	.00003669	.0000441
.007	.0065	.000049	.00004225	.0000455
.008	.0064	.000064	.00004096	.0000512
.008	.0060	.000064	.00003600	.0000480
.010	.0066	.000100	.00004356	.0000660
.010	.0068	.000100	.00004624	.0000680
.010	.0063	.000100	.00003969	.0000630
.012	.0079	.000144	.00006241	.0000948
.012	.0067	.000144	.00004489	.0000804
.014	.0076	.000196	.00005776	.0001064
.014	.0070	.000196	.00004900	.0000980
.015	.0071	.000225	.00005041	.0001065
.015	.0078	.000225	.00006084	.0001170
.015	.0073	.000225	.00005329	.0001095
.016	.0064	.000256	.00004096	.0001024
.016	.0075	.000256	.00005625	.0001200
.018	.0070	.000324	.00004900	.0001260
.018	.0080	.000324	.00006400	.0001440
.020	.0078	.000400	.00006084	.0001560
.020	.0070	.000400	.00004900	.0001400
.020	.0073	.000400	.00005329	.0001460
.021	.0077	.000441	.00005929	.0001617
.021	.0065	.000441	.00004225	.0001365
.024	.0067	.000576	.00004489	.0001680
.025	.0077	.000625	.00005929	.0001925
.026	.0084	.000676	.00007056	.0002184
.028	.0082	.000784	.00006724	.0002296
.029	.0075	.000841	.00005625	.0002175
.029	.0083	.000841	.00006889	.0002407
.030	.0077	.000900	.00005929	.0002310
.030	.0086	.000900	.00007396	.0002580
.548	.2246	.011266	.00164224	.0040795

This table supplies all the information required to solve for **r** in the preceding equation.

Σxy now equals 4.0795×10^{-3}
$\Sigma x \Sigma y$ is $0.548 \times 224.6 \times 10^{-3}$
Σx^2 is 0.011266
Σy^2 is 1642.24×10^{-6}
$(\Sigma x)^2$ is 0.548×0.548
and $(\Sigma y)^2$ is $224.6 \times 10^{-3} \times 224.6 \times 10^{-3}$

When these values are substituted in the equation,

$$r = 0.71$$

The value of **r** may be positive or negative and lies between plus and minus one. When all the points plot on a straight line, the value of **r** is one. When the plotted points cluster about a line, then the value of **r** is close to one. If the points plot as in Figure 4, then there is no correlation present. This means that values of the independent variable are of no help in predicting values of dependent variable.

Even when no correlation exists, **r** does not usually come out to be exactly zero. If the dots on a scatter dia-

gram were just put there by chance it is likely that **r** would have some plus or minus values close to zero, and to decide whether we have a chance scattering of points or whether true correlation exists, statisticians have calculated the limiting values for **r** as shown in Table III.

Table III—Values at which r is just significant for a given number of pairs of observations

N	r	N	r	N	r
10	.63	35	.32	90	.20
12	.58	40	.30	100	.19
15	.51	50	.27	125	.17
20	.44	60	.25	150	.16
25	.40	70	.23	175	.15
30	.36	80	.22	200	.14

For example, with a sample of 50, a value of $r=.27$ or more is considered to represent correlation. However, a value .26 or less is considered to be nuisance correlation, i.e., no correlation actually present. It is to be noted that the larger the value of N, the lower the value of **r** at which we can claim significance. This is because we have a better estimate of **r** with larger values of N. With a very small sample, it is possible to get a fairly large value of **r** when there is no correlation present. When there is a large sample taken, there is little chance that a large value of r could be obtained if there is no correlation.

In our example, in which there were 31 pairs of observations, a value of $r=0.36$ or more would be considered significant. The calculated value of $r=0.71$, indicates very definitely the existance of correlation.

A measure of the percentage of the variation of the dependent variable explained by the independent variable is r^2. If $r=.71$, then $r^2=.49$ and about one half of the variation of the dependent variable is explained by the independent variable.

The diagonal line in Figure 9 below is the line of regression. Having calculated the correlation coefficient, these same calculations are used to arrive at the line of best fit. The equation for this line is of the form:

$$y=a+bx$$

and it is necessary to calculate only the terms **a** and **b**. We calculate **b** first.

$$b=\frac{\Sigma xy-\Sigma x\,\Sigma y/N}{\Sigma x^2-(\Sigma x)^2/N}$$

and you will note that these sums may be read directly from the last row of Table II.

b is then found to be 0.06914.

a is determined next from the equation:

$a=\Sigma y/N-b\Sigma x/N$

and after substituting values already calculated, **a** is found to be 0.00602, so that the best line for predicting **y** from **x** is:

$y=0.00602+0.06914x$

One can easily see that all the points do not plot on the line. A band on both sides of the line may be established which should include nearly all the values. The equation for the measure of the spread of the points about the line is

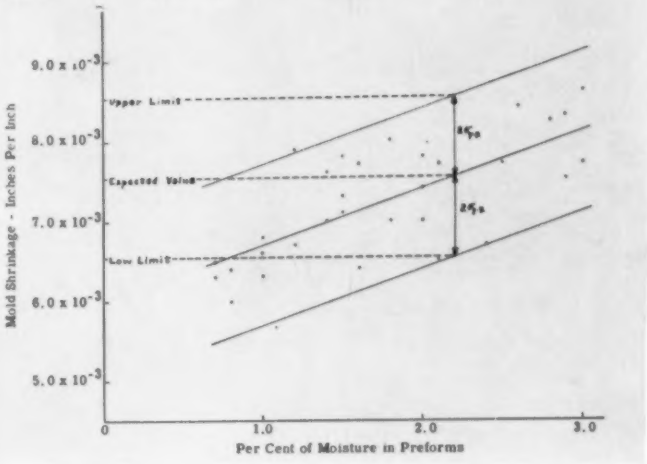
$$\sigma\,(y,x)=(1-r^2)^{1/2}\left[\frac{\Sigma y^2-(\Sigma y)^2/N}{N-2}\right]^{1/2}$$

where $r=.71$ in our example, Σy^2 and $(\Sigma y)^2$ refer to the values obtained at the foot of Table II, just as before.

A band of $\pm 2\sigma\,(y.x)$ is often used in correlation work. This band includes 95% of the pairs of values of the two variables. In Figure 10 for 2.2% moisture, the expected mold shrinkage is 7.5 x 10^{-3} with a lower limit of 6.5 x 10^{-3} and an upper limit of 8.5 x 10^{-3} which was determined by making the substitutions referred to above;

$\sigma\,(y.x)=0.506\times 10^{-3}=0.00051$.

Figure 10—Mold shrinkage vs. percent of moisture in preforms showing line of regression and 95% confidence limits.



The higher the value of **r** the closer the cluster about the line. The value of $\sigma\,(y,x)$ is small when **r** is large (close to one).

In summary, our correlation analysis of the shrinkage vs. moisture problem reveals the following:

(1) Without any question, mold shrinkage is dependent on the moisture content of the preforms. The data show that 49%, $(r^2=0.71^2=0.49)$ of the variability in shrinkage is accounted for by moisture. The remainder, 51%, is not identified.

(2) From the diagram (Figure 10) or from the equation, $(y=a+bx)\pm 2\sigma\,(y,x)$ one is able to determine;

(a) the expected mold shrinkage if the moisture content is known, and

(b) the maximum moisture content allowable to limit shrinkage to any specified value.

Up to this point we have been talking about simple correlation. This type of correlation is measured by the correlation coefficient. Multiple correlation is used when several variables are used to predict the value of one dependent variable. There is also partial correlation where

Scatter Diagram Examples

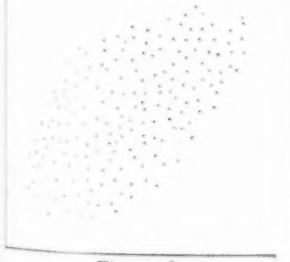


Figure 8

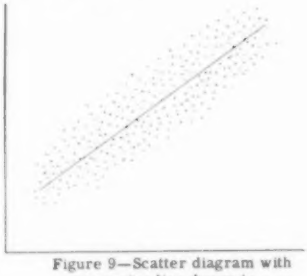


Figure 9—Scatter diagram with regression line drawn in.

one or more of the variables is held constant while other variables vary. There is also a type of correlation to be used when the relation between the two variables is not linear.

Several precautions should be remembered in using correlations.

1. Be sure that data are taken over the entire range of values of the independent variable for which information is desired. There is always danger in extending conclusions into a region in which no data were taken.
2. Check that the measurement of the data is not so inaccurate that it is covering up correlation.
3. Never eliminate some of the data unless there is good reason to.
4. Always check that the data plots as an approximate straight line, i.e., the trend line must be straight. If the line is appreciably straightened by plotting logs, reciprocals, or some other function of one or more of the variables, then this so-called transformation can legitimately be used in determining the correlation.
5. Check that the value of correlation obtained is actually significant and not a nuisance correlation. Table III shows that for larger values of N a smaller value of r is significant. Two variables would have to be very highly correlated to show significance in a sample as small as ten. Don't use extremely small sample sizes in correlation work.
6. Perhaps by way of caution, we should point out that correlation signifies only an association between the variables, rather than causation. The values of the dependent variable are associated with, but not necessarily caused by values of the independent variable. In Holland, the population of storks and the number of babies per square mile are closely correlated.

It has been indicated that correlation is very helpful in picking out the important variables affecting another variable. It may also be used between two parts of a test. If the two parts of the test correlate closely, only the first need be performed. Often it is not necessary to set up a test, but data already available can be used to discover important variables. Correlation is one more tool to be used in the search for answers to the problems in today's rapidly expanding plastics industry.

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AROUND THE WORLD

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UNITED STATES

ELECTRICAL MANUFACTURING

Vol. 54, No. 6, Dec. 1954

Abstracter: Gerald Eisner

VINYL-COATED STEEL HOUSINGS.* G. H. Kress

Mr. Kress of I.B.M. described in this article the results of a two year experimental program on vinyl-coated machinery housings. The advantages over painted steel were high abrasion resistance, range of textures, noise dampening and resistance to cleaning agents.

Their difficulties arose from the rigid requirements for aesthetic appeal and the impossibility of welding during assembly. To avoid adhesion trouble in cementing vinyl to formed steel, I.B.M. fabricated their housings from laminated sheet shock. They were able to overcome such difficulties as the splitting of the plastic in a 180° tight bend and the separating of the coating during punching and shearing. Even deep drawings were accomplished with the vinyl coated steel.

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ARGENTINA

PLASTICOS

Vol. 2, No. 8, July-Dec. 1954

Abstracter: John B. Ballard

THE "PLASTICS INDUSTRY HOUSE" IS A REALITY—Editorial

The Argentine Chamber of the Plastics Industry has recently purchased a building at the corner of Sarmiento and Larrea, in Buenos Aires. This will be used for the offices of the Chamber and of the Supply Co-Operative of the Plastics Industry. It will also be used for a permanent display of the products of the member companies, for meetings and lectures, and as a headquarters for members.

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AUSTRALIA

AUSTRALIAN PLASTICS

Vol. 10, No. 109, August, 1954

Abstracter: Albert Lightbody

EPOXY RESINS. N. W. Gillam, p. 6, 45-48

The commercial resins, made from epichlorohydrin and bisphenol are discussed generally in line with their manufacture, their properties and their uses, stressing the points where these materials are of greatest interest as in specialty adhesives, high-strength plastics, potting devices and foams.

PROGRAMME OF "THE WORLD OF PLASTICS" EXHIBITION

The exhibitors with their products and displays are listed. This exhibit was to be held in the Sydney Town Hall, 20-25th August 1954. This listing is quite educational as a discussion is given on the principal products of each company.

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GREAT BRITAIN

PLASTICS

November, 1954

Abstracter: A. T. Rexer

CO-POLYMER SHEET USED FOR NEW LIGHTING SYSTEM. pp. 357 and 358

This article describes the use of a calendered, corrugated vinyl sheet in lighting systems. Typical lighting installations are shown.

PLASTICS IN THE SERVICE OF MAN. pp 360 to 363.

Illustrations are shown of plastic units molded or otherwise fabricated in Great Britain for use as toys or games.

SOME PRACTICAL ASPECTS OF THE MANUFACTURE OF FORMS FROM PLASTICS. S. Matthews, pp 368 thru 370

This article is a reproduction of a paper given by the author during a special conference of Plastics Tooling. It describes in detail the manufacture of a large expoxide draw die.

THE CONTINUOUS WORKING KO-KNEADER MACHINE. pp 379 and 380

A Swiss company has developed a continuous working, worm type machine with kneading teeth which permits its use in the plastics field for purposes ranging from the mastication of p.v.c. to the coloring of semi-liquid pastes.

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MEXICO

HULE MEXICANO Y PLASTICOS

Vol. 9, No. 107, Dec., 1954

Abstracter: John B. Ballard

DEVELOPMENT OF AN INDUSTRY—Editorial

Reviews the history and growth of Celanese Mexicana, S. A., which started its first plant in April 1947 and now employs 2357 employees in four divisions in Mexico.

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NETHERLANDS

PLASTICA

Vol. 7, No. 9, Sept., 1954

Abstracter: W. P. ter Horst

PROTEIN-PLASTICS. E. M. Petri, pp. 449-451

Possibilities and difficulties in applications of protein plastics are discussed. With proteins complications arise, which are not present in other high molecular compounds: 1. The protein is built up from a great variety of monomers, about twenty different a-amino-acids. 2. The molecular chains in globular proteins are folded in a special way and have to be unfolded to be suitable for plastics. Finally crosslinking of the molecules is necessary. Various features of the chemistry of proteins, their processing and applications are discussed and possible improvements are suggested.

Vol. 7, No. 10, Oct., 1954

GLASS AS AN INORGANIC POLYMER II. J. M. Stevels, pp. 500-505

With the aid of steric models the structure of inorganic and organic polymers is compared. The structures of silicate and borate glasses are discussed. Furthermore the factors which are characteristic for these net structures and the connection between the value of these factors are mentioned, together with the physical and chemical properties of these glasses.

Three New Sections Join SPE at Conference

Central Indiana

D. D. James

On January 25, 1955, the newly-formed Central Indiana Section of SPE met officially for the first time, having been granted a Charter at the National Council Meeting at Atlantic City. Wayne I. Pribble, Pribble Plastics Products, Inc., was the guest speaker. Mr. Pribble spoke, in his usual perceptive and entertaining manner, of "Profit and Loss Factors in Mold Design."

Advance reservations indicated an excellent turnout of about 70 people, approximately the same number who attended the organization meeting. Extremely bad weather struck, however, and it was very gratifying to have 39 people present, despite radio warning to stay off the roads. Two groups from 75 miles away were amongst those present.

The following men were elected Directors for 1955: E. C. Quear, D. D. James, W. K. Millholland, Jr., Dale Amos, Harold Riley, Jr., A. B. Hitchcock, C. R. Smith, J. O'Sullivan, and Wayne Nicely.

The newly-elected Directors then named the following officers for 1955: President, E. C. Quear, Delco Remy Div., GMC; V. President, D. D. James, E. I. duPont deNemours & Co., Inc.; Secretary, W. K. Millholland, Jr., W. K. Millholland Machinery Co. (Watson-Stillman); Treasurer, H. G. Riley, Jr., Riley Heating & Equipment Co.; National Director, Dale Amos, Amos Molded Plastics.

The following men are to be considered Charter Members of this Section: Wayne DeCamp, C. R. Smith, Robert Hittle, Robert Johnston, S. Wamsley, W. K. Millholland, Jr., G. P. Humfeld, D. A. deTartas, H. G. Riley, Jr., J. S. Ferguson, J. F. Sundstrom, A. B. Hitchcock, Dale Amos, Dale E. Hickey, Sherrill Harvey, Charles Chitwood, Walter E. Fisher, Maurice Scott, Leon I. Davis, W. P. Miller, R. J. Testolin, L. A. Black, Jr., W. C. Graves, F. M. Adair, A. H. Voss, D. D. James, J. O'Sullivan, J. M. Kendrick, Oscar Ogden, R. Wilds, Norman Krone, Wayne Nicely, S. D. Ransburg, J. M. Cox, John Lloyd, E. A. DeBoo, F. H. Drummond, and E. C. Quear.

Kansas City

John R. Albert

Despite 4" of snow, the fourth meeting of this group took place as scheduled on February 1, with 31 in attendance.

There were two speakers, the first being Mr. M. H. Straight, Advertising Manager of Spencer Chemical Comapny, whose subject was "Power of Advertising." Second speaker was Professor Ken Rose of Kansas University, Head of the Mining and Metallurgical Engineering Department, whose subject was "Usual and Unusual Metals."

The door prize, a dispatch case supplied by Regal Plastic Company, was won by Bill Prelogar of National Products Company.

The newly received charter for this section was exhibited and after a short discussion concerning activities of National Committees, growth of SPE and forthcoming convention locations, the meeting adjourned.

Officers and directors elected are: President, John E. Ferguson; Vice-President, George Roach; Treasurer, M. L. Davis; Secretary, K. A. Kaufmann; National Committeeman, F. C. Sutro; Program Committee, P. G. Fleming, Robert Thomson, K. A. Kaufmann, F. C. Sutro; Membership Committee, Jerome S. Kivett; House Committee, Paul W. Foote; Journal Reporter and Publicity, John R. Albert.

Pacific Northwest

R. A. Fulton

The decision to petition the SPE for a formal establishment of a Section in this area came as a result of an organization known as the Pacific Northwest Plastics Association which was a loosely-connected organization mainly held for the purpose of occasionally getting the plastic industry together in this area and whenever a meeting was warranted due to the visit from some notable in the plastic business from which we could learn something.

The organization comprised members of the injection molding extrusion, fabricating, laminating and tool making fields in Washington, Oregon and British Columbia, Canada.

(Please turn to page 33)

Pacific Northwest Officers
Bud Cole, Vice-President; Bruce Stewart, Secretary-Treasurer; and Marvin Carr, President.

CENTRAL INDIANA officers are E. C. Quear, President; D. D. James, Vice-President; H. G. Riley, Jr., Treasurer; W. K. Millholland, Jr., Secretary.

FRED C. SUTRO, National Committeeman Receives Charter for Kansas City Section from John LaBelle and Joe Healey.

SECTION NEWS

Edited by

Stanley Bindman

Jamison Plastic Corp.
1255 Newbridge Road
North Bellmore, L. I., N. Y.

New York

Meeting With Reinforced Plastics Group

Arthur M. Merrill

The January 5th meeting of the New York Section, SPE, was held jointly with its Reinforced Plastics Group at the Gotham Hotel. Following dinner announcements were made of tentative programs for the year and the appointment of the following committee chairmen: membership, A. S. Jacobs, Augusta Plastics, Inc.; employment, A. L. GeWertz, manufacturers representative; education, H. J. Weber, Rotuba Extruders, Waljohn Plastics, Inc.; and publicity, A. M. Merrill, Plastics Technology.

The topic for the evening was expanded plastics and a panel of experts with John Alfers, Bureau of Ships, Navy Department, as moderator, spoke on six types of resin foams and showed samples of the latest developments in that field.

Don Weyer, Dow Corning Corp., discussed "New Developments in Expanded Silicone Resins," including a process for foaming them in place. New "ready mix" powders obviate the need for hand blending, and require only heat to melt, foam, and cure. Before the final cure, sections can be cut from the foam and reheated to make formed insulation around air ducts and pipes where foaming in place is not feasible. Physical and electrical properties of the resin permit its use in thermal insulation, radome structures, and electronic applications.

"Expanded Phenolics, New Developments in an Old Reaction" was the subject presented by R. P. Courtney, Bakelite Company, who noted that the foams were considered originally as undesirable end-products of the phenol-formaldehyde reaction. In a properly controlled reaction, inexpensive foams are produced which can be machined and used for insulation or packing. Being thermosetting, foaming in place is not possible. Recently developed "syntactic" foams offer light weight with strength and form retention.

Isocyanate foams, as outlined by Mark Stringfellow, Nopco Chemical Company, in his talk on "Expanded Isocyanate Plastics," are a recent German import. A combination of alkyd resin and diisocyanate they offer temperature stability, moisture resistance, tear strength, good adhesion when foamed in place, and excellent electrical properties. Flexible and rigid foams are both available. The process is relatively simple; when diisocyanate is stirred into viscous alkyd resin copolymerization occurs. The mixture can be poured directly into a cavity and foamed in place.

An expandable vinyl plastic which can be foamed in place at atmospheric pressure was described by Gabriel Goldstein, Interchemical Corporation. Called Vynafoam, it can be forced into gasketing channels by a high-pressure pump attached to a spray gun, eliminating the need for pre-cutting and installation of gaskets. Expansion is accomplished by heating the vinyl plastisol with a blowing agent to a temperature of 250-400°F., depending on the formulation.

A continuous extrusion process wherein cellulose acetate is converted to unicellular foam by the flash vaporization of a super-heated volatile solvent, was presented by John Valentine, Strux Corporation, in speaking on "Cellular Cellulose Acetate." CCA offers temperature stability, buoyancy, machineability, and ease of bonding. The material must be fabricated to shape; it cannot be foamed in place.

Polystyrene foams offer high impact strength, according to E. A. Edberg, Koppers Company. Shipped in beads, they can be foamed either by the direct introduction of steam into a mold or by the steam-probe method, with an expansion cycle of 20 seconds to one minute. Expanded polystyrene can be foamed in place, reinforced with chopped glass, glued, and laminated.

The meeting closed with the distribution of door prizes donated by Bassons Industries Corporation.

Ontario

Panel Discusses Business Ethics

On January 11, 1955, the Ontario section of the Society of Plastics Engineers held its monthly meeting at the St. Regis Hotel in Toronto. At this meeting a panel discussion took place on the topic "Business Ethics in the Plastics Industry".

Mr. Barney Danson acted as moderator and the panel group of four represented various phases of manufacturing. Mr. James Wallace, sales manager of Dulev Plastics Limited (injection moulders), Mr. Ralph Harrison, sales manager of Canadian General Electric Company Limited Plastics Division (compression moulders), James Fuller, Rainbow Plastics (compression moulders), and Mr. Gordon W. Beatty, Micro Plastics Limited (extruders) sales manager, all presented their views.

Mr. Wallace concentrated on mould design. There has been much confusion on the part of buyers on mold amortization which should be clarified. Mr. Wallace also mentioned the 25% profit and engineering cost to remove a mould which had been designed on a non-profit basis. The contention by many was that several moulders have the die made for them and therefore the mould was not purchased at cost price and the 25% tag was excessive. The speaker also felt that several moulders were making wild quotes as they had not seen a mould and it would be better for the people presently keeping the die to allow the other interested moulder to see for himself what the article should cost.

Mr. Harrison took on the engineering aspects and was very critical of machinery equipment suppliers who invited captive moulding by supplying misleading information on the costs to the interested parties. He added also that the industry should provide the proper technical information to customers or in the end people would be using a poorly designed product, sometimes with the wrong material and giving the industry a bad name.

Mr. Fuller concentrated on economics and mentioned that moulders should be more informed about their costs as quotations varied all over the map leaving poor impressions on customers. He also felt that the government was very lax in permitting moulded articles into the country, as, although duty had been collected, there is no charge being added for mould cost and amortization.

Mr. Beatty was very critical of raw material suppliers competing with their customers. It was his feeling also that too much information about what one manufacturer was doing was being passed along by the material suppliers.

Western New England

Estimating Costs in Tool Shop And Cost of Molded Parts Covered in Talks

M. G. Snyder

An enlightening discussion of some of the problems—some humorous, some not so humorous—that plague the workaday life of a tool and die cost estimator highlighted "Estimating Night" at the Western New England Section's January 5 meeting, held at Bradley Field's plush Terrace Dining Room in Windsor Locks, Conn.

Mr. Alvino Aliberti of the A. & M. Tool and Die Co., Southbridge, Mass., delighted a group of 80 members and guests with his witty handling of the difficult and timely topic, "Cost Estimating in the Tool Shop." The point that the success or failure of a tool and die shop can well rest on the skill of the cost estimator, was sharply driven home by Mr. Aliberti.

Using a sample cost estimate sheet as the outline for his discussion, Aliberti clearly defined the mold cost problem from the estimator's point of view. He pointed out that the mold estimator and the production estimator seldom see the job in the same light. Whereas a production man evaluates the cost of a job in terms of dollars and cents, a tool estimator has to think in terms of labor and material requirements to produce the tool components.

Since 80% to 90% of the average mold making job is labor, he said, figuring the labor factor accurately in hours is of utmost importance. Being the greatest variable, it is also exceedingly difficult to calculate. "No two molds are ever alike," Aliberti said, "consequently, each estimating job is a brand new problem. It is precarious, if not impossible, to base any estimate on comparisons with previous jobs or similarities in the design of two different molds. Even where constants may exist, such as in the specification of metal to be used, other variables can easily distort a direct comparison," he said.

Because it is necessary for an estimator to be able to ascertain to close approximations the various labor steps involved, such as hobbing, machining, making core inserts, polishing, etc., he should be a man that has come up through the ranks, Aliberti said, adding that "a good estimator is almost always a skilled tool maker and machinist in his own right."

Among important data an estimator should have available before he tackles the job of cost analysis, Aliberti listed a **detailed** drawing of all requirements first. "50% of the time," he said, "a mold estimator finds himself working only from a product sample or a model. A satisfactory cost figure can seldom be determined from a product sample, which means that a finished drawing has to be made and a sample mold built to analyze design and construction details of the mold." He added that even an assembly drawing of the mold is seldom sufficient, and forces the estimator to guess at requirements for omitted details.

The human factor also ranks high in Aliberti's opinion of proper estimating procedure. "An estimator should have a thorough knowledge of individual differences and work methods practiced by machinists in the plant who will work on the job. There are often variances in the time two different tool makers can complete the same work step, and unless allowances are made for this factor it can throw other cost figures out of line," he said.

Aliberti stated that the large number of these variables that exist in each job, and in each shop, provides a big part of the answer to the question of why there is often a large "spread" among quotations figured by four or five different estimators on the same job. This is also why, he said, most estimators allow themselves a "safety factor" over their labor cost figure. This margin for error is not figured on a flat percentage basis, but is reckoned from the nature of job requirements in each case. It helps to compensate for such unforeseen problems as having to change from a hobbing to a machining operation midway through a job because of engineering difficulties that could not be known in advance, he said. "Where there is a question about method," he added, "a smart estimator will figure on the more difficult way in the event the preferred method won't work out."

"The thing that makes an estimator's job so frustrating," Aliberti concluded, "is the fact that he is always working with approximations that vary from one job to the next. The only time he can be certain of his calculations is after the job is completed, and since each job is a different problem, he never gets the chance to apply his exact knowledge about a particular job ahead of time."

Following Aliberti, George W. Martin, president of Noma-Lites, Inc., Holyoke, Mass., and president of the Western New England Section, explored the other side of the cost estimating picture in a talk on "Estimating Cost of Molded Parts."

"The first step in production cost estimating of a plastic part," said Martin, "is to make a thorough study of drawings and samples to determine if the item is moldable." He pointed out that it is often helpful to make a rough sketch of core and cavity details as part of this analysis. "The second step," he said, "is to determine if the job is adaptable to the type of molding equipment available in the plant." This means figuring whether sufficient capacity of the necessary type and size is available to meet the required production and delivery dates. "These preliminary studies should be completed before any attempt is made to estimate the cost of producing the part," he added.

Martin outlined a number of factors involved in arriving at the finished piece price estimate. In outline form these steps included:

1. Estimating the quantity and type of molding material required. This means calculating the cubic volume of the part, unless an actual molded sample is available for weighing. It also involves checking availability and current price of the specified material as well as an alternate if one is being considered.

2. The problem of preforming should be considered next, unless the bulk load factor can be determined by an existing mold. What is required here is to check the number of preforms required for the molded part and to estimate the production per hour involved in the preforming. An alternate procedure would be to utilize preforms of such materials as Fiberite or Rogers board, adding the cost of preforming to estimated material cost.

3. In figuring actual production cost per hour, the cycle time multiplied by the number of cavities can be used to arrive at the incentive standard. Cycle time, in this case, is calculated by figuring loading, closing, curing, opening, unloading and mold cleaning time. The number of cavities required is determined by assessing the production requirements of the cycle. Set-up time should also be figured in if continued short run quantities are anticipated.

4. Post-molding activities, such as de-finning, finishing, assembling, packing and shipping, are essentially problems of time and technique, as individual requirements often change with each job. It is therefore a good idea to review all of these requirements from the standpoint of time-and-motion economies on each job.

5. Tooling cost, which involves preform tools, molds, accessories, finishing and assembling fixtures, are often indicated by the tool and die estimator's figures. In arriving at approximate mold cost as a factor in the total piece price, however, it is always a good idea to submit a fairly complete drawing to several experienced mold makers as a check on proper mold cost computation.

(Please turn to page 32)

Milwaukee

New Officers Are Announced . . . Polyethylene Properties Told at Meeting

H. Jay Tapper

The January 11, 1955 meeting of the Milwaukee Section, attended by about 50 members and guests, took place at the John Ernst Cafe. A brief business meeting followed the dinner, where due to cancellation of the December meeting, the first public announcement of our annual election was made. The results were as follows:

President, John A. Verburg, Continental Can Co.; Vice Pres., Jack K. Godfrey, Sunlite Plastics, Inc.; Treasurer, George A. Stein, A. O. Smith Corp.; National Director, Eugene Slingluff, Sunlite Plastics, Inc.; Secretary, Walter F. Just, Jr., B. J. Plastics.

The Section Directors as follows:

John A. Verburg, Continental Can Co.; George A. Stein, A. O. Smith Corp.; Eugene Slingluff, Sunlite Plastics, Inc.; F. B. Shaw, Continental Can Co.; H. C. Klein, Jr., Sunlite Plastics, Inc.; A. C. Anderson, A. O. Smith Corp.

After the meeting our past president Mr. George Stein introduced Mr. James R. Wilkinson of the Bakelite Corp. Mr. Wilkinson holds a B.S. in Chemistry from Penn State, and has been with the Bakelite Corp. since 1941, excluding a three year tour with the navy.

The topic for the evening was polyethylene, its molding characteristics, and recent developments. Since a number of those present were somewhat unfamiliar with the subject, Mr. Wilkinson gave the group a good basic understanding of its manufacture and uses.

First point was in manufacturing polyethylene—the tremendous pressures and equipment required and the difficulties presented by the gaseous by-products. From there he explained how the bulk of the polyethylene gas is converted to a usable product, falling into several groups distinguished by their molecular weights. Each group offers special molding properties and strengths. Also explained were molding techniques such as proper temperatures, pressure was one highly stressed point, and gating. The conclusion of the gating problem indicated that extremely small gates are required for the injection molding of polyethylene. The recommended gates ranged in size from around eight mils to .040" the least shrinkage and the best possible surface finish. Temperature and pressure are also important factors.

Polyethylene has different molding properties than other plastics, since high pressure and low temperature produce the least shrinkage in most cases. Due to the variable shrinkage of polyethylene, Mr. Wilkinson strongly recommended the use of experimental molds in obtaining the greatest perfection in the molding process.

The rapid increase in consumption of polyethylene has brought the price downwards very rapidly to a level highly competitive with similar resins.

Mr. Wilkinson had available for inspection a dishpan about 24" in diameter and 6" high, recommended because of its flexibility causing a reduction in the breakage of dishes, yet the pan was sufficiently solid since there was no evidence of sag. Another article was a catsup dispenser shaped like a tomato, which had an extremely fine surface finish. At this point Mr. Wilkinson mentioned that stresses set up in a polyethylene squeeze bottle are subject to oxidation by certain chemicals producing hairlined imperfections. This phenomena is not yet understood by "the boys in the lab."

A polyethylene practice golf ball molded in two parts and heat sealed together was used to illustrate the strength obtainable by this type of bond. This also led to a discussion of adhesion of polyethylene to other materials or itself. The facts show there is nothing that will provide a satisfactory bond, aside from heat.

The wastebasket molded in polyethylene turned out to be a decorator's delight. Good even color along with ease of cleaning were among its qualities.

The talk was closed after a few questions on the chemical structure and the effects of radiation.

We of the Milwaukee Section of the Society of Plastic Engineers would like to take this opportunity to thank our past officers, particularly George A. Stein of the A. O. Smith Corp., our past president, for the great job they did this last year.

Toledo

Test Tube To Home Ladies Night Topic

R. E. Dunham

On Nov. 17, the Toledo Section held its annual Ladies Night at the Hillcrest Hotel. Twenty-six couples attended. Following dinner, door prizes were distributed and the featured drawing for a ladies fur piece was held. Elmer Faber and George Johnston arranged the special program.

Mr. Jack Bolster, Home Furnishings Promotion Manager for McCall's Magazine, gave ideas on plastics applications to the ladies in his talk entitled "Out of the Test Tube into the Home." Slide film was used to illustrate the talk. Some of the items covered were:

1. What plastics are.
2. Where plastics are found in the home.
3. Differences in plastics which enables the right one to be selected for the job.
4. Suggestions as to "Being kind to plastics" with particular reference to following instructions on labels.

The Toledo Section assembled at the Stork's Nest on Dec. 15 to hear a presentation of "The Apprenticeship of Tool and Die Makers." The program was followed by a buffet luncheon. About forty were in attendance.

Mr. Erik Kohler, manager of the K & M Machine Co., Walter Scott, representative of the Board of Education, and Henry Preslonski, representative of the Federal Bureau of Labor, presented the program. A film on Apprenticeship Training prepared by the National Tool and Die Manufacturing Association was shown.

The need for more apprentices was emphasized along with the predicted increase in demand for tool and die makers. Programs for apprentices at different industries in the Toledo area were reviewed. The cooperation of the Toledo Board of Education, the state of Ohio, Federal government, and industry was discussed.

Southern California

Plastics in Naval Ordnance Uses Are Described

Felix C. Karas

Mr. W. E. Donaldson, Supervisor of the Materials Engineering Division of the U. S. Naval Ordnance Test Station, Inyokern, was the speaker of the evening at the January 20th joint meeting of the SPE and the SPI. Mr. Donaldson's topic was "Plastic Materials in Naval Ordnance" and included the presentation of moving pictures showing the firing of a B-4 track sled for rocket testing and the fabrication of a plastic laminated rocket motor tube. Mr. Donaldson touched various plastics problems encountered in Naval Ordnance and illustrated his talk with several samples of parts molded or fabricated of plastic materials. An audience of over 160 persons attended the meeting presided over by Mr. Wm. Dewar of Standard Plastics.

Buffalo

Plastisol, Organosol Uses Described

R. W. Miller

The Buffalo Section met December 10, at the Park Lane. Speaker for the meeting was Robert Norum of the Surface Coating Division of Bakelite. Mr. Norum presented an interesting description of plastisols and organosols and pointed out numerous applications. The following is a resume of Mr. Norum's talk.

Plastisols are dispersions of very finely ground vinyl chloride or vinyl acetate in a plasticizer that is not a solvent at room temperature. The particle size of the resins used is 2 microns and finer. Organosols are basically plastisols to which a volatile thinner has been added. This is usually done to lower the viscosity.

These materials must be fused or baked. Any source of heat may be used and temperatures employed can vary from 250°-400° F. depending on the formulation. At a certain temperature the plasticizer solvates the resin particles and finally fusion takes place.

These materials can be used as sprays, dips, molded and knife or roller coated. Plastisols are resistant to water, detergents, acids, alkalies and oils. Following are a few interesting applications that Mr. Norum pointed out:

1. **Plastisols Molds.** Considerable success has been achieved by using plastisols to make molds. Molds can be made in 1½ hours from plastisols as compared to 4 hours for plastic. Plastisol molds produce parts that do not require finishing. One large appliance manufacture utilizes plastisol molds to produce prototypes to determine customer acceptance by means of surveys.

2. **Foamed Plastisols.** These materials can be foamed into materials having connected cells so they will act as sponges or into materials having nonconnected cells so they will float. The latter type has found considerable use as fish net floats.

3. **Electrical Uses.** For electrical applications a base resin of electrical grade with a minimum of impurities must be used. These materials have been used for potting compounds and for filling voids in electrical cables.

4. **Slush Molding.** For this type of molding a plaster mold can be successively copper plated until a fair size coating is obtained. The plaster is then removed. The copper mold is then filled with plastisol and the excess poured off. The film is then cured. Additional coatings will build up the film if necessary. One manufacturer produces 6000 pieces/hour by utilizing 200 molds. Types of products made by this method are women's overshoes, flexible bottles and fish lures.

5. **Organosol Applications.** These materials are normally sprayed and fused at about 350° F. They have been used successfully for protecting metal chairs from abrasion and greases and oils. The dashboard of the 1955 Desoto is coated with an organosol.

At the end of the meeting the results of the election for Board of Directors was announced.

Elected to a 3-year term:

R. A. Baumgartner, Carborundum Co.; H. J. Deney, Pierce & Stevens, Inc.; K. L. Ditzel, Lucidol Division Novadel-Agene Corp.

Elected to a 2-year term to fill out the unexpired term of a departing member:

R. W. Miller, Carborundum Co.

Elected to a 1-year term to fill out the unexpired term of a departing member:

R. D. Thilk, The Vorac Co.

A Board of Directors meeting was held December 29, and the following officers elected:

Pres., Paul H. Bronnenkant; Vice Pres., Eugene C. Roeck; Secretary, Robert W. Miller; Treasurer, Edmond A. Leone.

Detroit

Responsibility Is Panel Topic

Mac Nichols

In their first meeting of the New Year, the Detroit Section of the Society of Plastic Engineers held a dinner meeting on Monday, January 17 at the Rackham Memorial Building.

President Carl Whitlock presided at the meeting which was primarily dedicated to business matters. The Treasurer's Report for the past year showed a sizeable increase in the bank balance of the group, and the Membership Chairman reported that 59 new members were added to the roster, or an increase of 35% over the previous total.

The new officers of the section for 1955 and the Chairmen of the functioning committees were introduced and acclaimed. They are:

President, Iver Freeman; Vice President, Roy Smith; Secretary, Fred Schwab; Treasurer, Don Kocher; National Director, Don Hoffman.

The following chairmen were appointed by the newly elected President:

Program Chairman, Jay Kuhn; Membership Chairman, John Slater; Credentials Chairman, Jack Totten; Educational Chairman, Harry McGowan, Jr.; House Committeemen, Richard Denny and Hugh Whitlock; Professional Activities, Harry McGowan, Jr.; Publicity, Mac Nichols.

It was announced by Mr. Whitlock that all of the Technical Sessions for the balance of the year would be held at the Rackham Memorial Building on the third Monday of each month, with the next four meetings being scheduled as follows: February 21, March 21, April 18, and May 16.

Then followed one of the most interesting and spirited round table discussions of the year, under the direction of Don Kocher, Program Chairman. The members gave thorough coverage to the varying phases of "EXACTLY WHERE DO THE RESPONSIBILITIES OF THE PLASTICS INDUSTRY LIE?"

Draftsmen, designers, mold makers, molders, machinery manufacturers, and end users aired their viewpoints on this controversial subject, and it was the consensus that there is an overwhelming need in our plastics industry for capable Design Engineers to function as directors and co-ordinators between the various shops, thus assuming full responsibility for acceptable production parts in a given proposed plastic program.

It was also felt that there is an unfortunate lack of coordination by the plastic machinery maufactures who could readily ease some of the burdens of the plastic material molder by standardizing many of the critical working parts in the mechanics of their molding equipment.

Comparisons were made between the problems encountered in the die-cast fields and the plastic industry, and opinions were expressed that brought active responses from many members.

Western New England ...

(Continued from page 30)

Before any actual production work is begun, Martin said, an estimate should be figured which includes the **total** estimated cost for labor, overhead, material, scrap—and should also include the gross profit expected on the job.

In addition to the talks by Alibert and Martin, a special feature of the evening was a 12-minute movie on the subject of "Production Plating of Tin Strip Stock," presented by Arthur W. Logozzo, president of Nutmeg Chrome Corp., Hartford, Conn. The film was shot by Logozzo during a recent tour of one of the largest tin plating installations in the world, a subsidiary of National Steel Corp. It displayed views of the immense plating facilities of the multi-million dollar installation, and lent appropriate emphasis to the evening's discussions on phases of tool and die cost estimating.

Southern

Fiberglas Uses Are Described

C. Veazey LeCraw

The January meeting of the Southern Section was held on January 10 at Mammy's Shanty. The subject of the meeting was "Fiberglas." A very interesting group of speakers told of applications of Fiberglas for reinforced plastics in a wide variety of products.

Included in the array of speakers were Mr. Charles F. Marschner, Production Engineer at Lockheed Aircraft Corporation, Georgia Division, who spoke on "Reinforced Plastics in Aircraft"; Mr. W. M. Keller, Vice President and General Sales Manager of Owens-Corning; Mr. J. W. Dougherty, Manager Consumer Goods Section, Owens-Corning; Mr. Matt Nemeyer, Manager Plastics Division, Owens-Corning; and Mr. George Hammond, also of the Plastics Division of Owens-Corning.

Mr. Marschner discussed the various advantages of reinforced plastics in aircraft. These include (1) high strength-to-weight ratio, (2) excellent corrosion resistance and weatherability, (2) excellent electrical properties including "radar transparency," (4) ease of producing intricate shapes, and (5) non-critical materials. He then expounded on what the aircraft industry needs in the way of a reinforcement for plastics which will greatly expand the use of these materials for aircraft parts including primary structure. These needs include (1) greater elongation — preferably 7%, (2) higher stress-strain ratio, (3) more uniformity of properties in all directions, and (4) standardization of properties so that designers will not be confused by the variation in information from different sources.

Messrs. Keller, Nemeyer, Dougherty, and Hammond discussed the development of the process for manufacturing the basic fibers and elaborated on the many and varied uses of Fiberglas for reinforcing plastics. Among the main applications of Fiberglas reinforced plastics are the automotive field, corrugated panels, signs with integral lettering, and "gunk" molding compounds using alkyds, polystyrene, phenolics, melemines, etc. There was a long question-and-answer period following the discussions. The many questions further indicated the great amount of interest in this relatively new field of plastics.

The Program Committee announced that the subject of the February meeting will be "Polyethylene" and for the March meeting the subject of "Polyesters" has been chosen. Meetings, beginning in February, will be on the third Monday of each month.

Pacific Northwest

(Continued from page 28)

Since the group grew so rapidly in the last two to three years, it was definitely felt that a more tightly knit, well organized group would be much more beneficial to the trade in general; therefore, SPE was looked into by the committee appointed for the purpose and a formal presentation of what the SPE had to offer was presented to the membership. It was unanimously agreed at that time that we should petition the SPE for the establishment of a Chapter in this area. Those largely responsible for this move are those which are listed as temporary officers.

The Pacific Northwest Section of SPE held their organizational meeting on Thursday, January 27. The following is the list of the Board of Directors elected at that meeting; Marvin Carr, Berton A. Cole, R. A. Fulton, Bruce Stewart, Richard T. Davidson, James H. Wiborg, Leonard J. Vaupell, Merrill Roth, D. M. Agnew.

Officers for the new section elected from the Board of Directors at the same meeting are as follows; Marvin E. Carr, President; Berton A. Cole, Vice President; R. A. Fulton, Secretary; Bruce Stewart, Treasurer.

Mr. Boris Korrey was appointed Director on the National Council.

The following Committees and Committee Chairmen were appointed by the joint action of President Marvin Carr and the Board of Directors.

Program Committee, House Committee and Publicity Chairman—Bud Cole.

Membership Committee, Credential Committee Chairman—Don LeGassey.

Education Committee, Finance Committee Chairman—Bruce Stewart.

Election Committee, Auditing Committee and Nominating Committee Chairman—Frank Lee.

Bamberger Sold

It is being announced that Mr. Norman Eisenstein, President of Ansbacher-Siegle Corporation, Rosebank, N. Y. and Federal Color Laboratories, Cincinnati, Ohio, has acquired the business conducted by A. BAMBERGER CORPORATION as well as of its affiliate, AMERICAN MOLDING POWDER AND CHEMICAL CORPORATION, plastics materials manufacturers, Brooklyn, N. Y.

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Newark—New York

Panel On Tooling For Plastics Covers Main Problems

D. J. Mullins

Approximately 200 members and guests of the New York and Newark Sections attended a panel discussion on "Tooling For Plastics" at a joint meeting of the two sections which was held at the Military Park Hotel, Newark, New Jersey, on January 12th. The panel members were Ernest Csaszar, Chief Engineer of Eagle Tool and Machinery Company, Edmund Spitzig, Hobbing Supervisor, Newark Die Company, Joseph P. Healey, Vice President of Manco Products Inc., W. J. B. Stokes, President of Stokes-Trenton Inc., and Richard Savage, Product Director of Marco Products Department, Celanese Corp. E. B. Soules of Detroit Mold Engineering Company acted as moderator of the open forum which followed the presentations by the panel members.

Csaszar spoke on "Advantages and Limitations of Making Plastic Mold Components by the Process of Machining." Csaszar pointed out that many factors enter into the selection of the method to be used in making mold components, some of which are:

1. The type of molding to be done—whether it is injection, compression, transfer or low pressure. These factors give an indication of the type and amount of stresses to which the mold components will be subjected.
2. The amount of production anticipated gives a measure of the required endurance to be built into a mold. For short runs, for instance, often methods of construction can be used that would not be suitable for high speed, long production runs.
3. Cost is another factor of construction. Budget allowance and/or competition often mean to the molder the difference between getting or losing a job.
4. The shape of the part to be molded is another factor. In some cases certain cavity or force sections are not readily machinable and hobbing or pressure casting is indicated. In other cases, the reverse is true and machining and setting in sections is the better method. This and the aforementioned factors should be discussed between the molder and moldmaker.

Csaszar then reviewed the advantages of machined molds, some of which are:

1. One of the greatest advantages is the almost limitless selection of materials to be used. Other methods such as casting, electroforming and even hobbing are limited to a relatively few alloys from which to choose. For example, compression molds land areas are often subjected to extreme compressive stresses. Cavities and forces must have high surface hardness coupled with tough core qualities to prevent collapsing of the cut off area under these extreme pressures. If the cavity or force is machined, there are a large number of special steels to choose from to get the qualities of high compressive strength coupled with high surface hardness. The materials of construction which some of the other methods are limited to, in most cases, do not have some of these properties. Machining of injection molds alleviates the dangers of heat treating, distortion and cracking. Actual sizes cut into pre-hardened steel are the sizes that will be on the finished mold.
2. Machining often allows more cavities in a given space. Hobbed or cast cavities are usually made as individual units, must be individually machined on all sides and individually fitted into a retainer of some sort and must have a certain wall section to withstand molding pressures. Machining allows the cutting of all cavities into a solid plate which cuts down on required space because two adjacent cavities can use a common wall section.
3. Size is another advantage of machining. Hobbying, berrylium casting and electro-forming are all in some way limited as to the sizes that can be readily handled.

Csaszar concluded by stating that machining molds does have some limitations which he assured would be discussed by the other speakers who followed him on the platform.

Spitzig gave an outline on "Hydraulic Hobbing in Steel" and he explained that mold die hobbing is a specialized way of making steel cavities by sinking a properly hardened and polished steel master into a piece of relatively soft metal under heavy hydraulic pressure. When the hob has been sunk, the cavity produced in the steel blank is as highly polished as the hob. Modern hobbing steels, press equipment and techniques have made it possible to produce cavities in larger sizes, in more difficult shapes, and within closer limits than were practical in the early days of plastic molding.

Spitzig stated that a number of factors should be considered before deciding to hob. The design of some parts will call for bosses, shoulders, thin sections and undercuts which would make the hobbing method difficult to impossible. Some of the difficulties may be overcome by a combination of hobbing and machining after hobbing. On the other hand, Spitzig advised there are designs that are perfect for the hobbing method and the possibilities of hobbing should never be overlooked.

Spitzig stated that there are three steels generally used for hobbing:

1. Swedish iron which allows maximum hobability with less danger of hob breakage due to its low carbon content and lack of other alloys. Swedish iron may be used for injection and transfer molds but is not recommended for compression molds as the core strength is not very high beneath the carburized surface.
2. Steels that have good strength and are recommended for compression molding are known as alloy hobbing steels. A typical analysis shows carbon .10, manganese .20, silicon .20 and chromium 2.25. This steel will case harden to Rockwell C-64 with a core hardness of C-25 to 28.
3. The third type of steel which is finding favor with both plastic and die cast molders has a still higher core strength of C-40 to 45. A typical analysis of this steel is carbon .10, manganese .30, silicon .20, chromium 5.00, molybdenum .90 and vanadium .25.

Spitzig stated further that hobbed cavities are not always limited to steels that have to be carburized as in some instances they can be made in water and oil hardening tool steels. Bullet, ball and cone shapes can and have been sunk to considerable depths in these steels. Flats, such as wall tile due to their shallow depth, have also been hobbed with very satisfactory results.

Spitzig concluded by saying that whenever it is practical, hobbed steel cavities are more economical, last longer and are more trouble free than any other method of producing multiple cavities.

Healey spoke on "Pressure Casting of Beryllium Copper." He stated that beryllium has proven its capability through many years of hard usage with a definite saving being shown in a proper application competently augmenting steel in attaining complex forms or shapes which would be more costly if considered in steel. Healey pointed out that the nature of the finished part establishes the value of using the beryllium copper pressure casting process. If the piece to be produced is of a regular or geometric shape that would lend itself to machine tooling, or if a sinking with

ast a case hardness will suffice, beryllium copper will usually offer little in the way of benefits to justify any additional expenditures that may be involved, Healey said. However, when there is a production run requiring high thermal conductivity or when cavities must have uniform hardness and density throughout, beryllium copper fills the bill in securing the proper molds, Healey said. In addition, according to Healey, beryllium copper should be considered when there is any problem of high hob mortality, when sinking is prohibitively expensive or impractical, or when the job requires thin projections, intricate engraving, complexity of design, fluting, serrations or complicated parting lines.

Healey advised the audience that beryllium copper has pointed the way to new plastic applications for plastic fabrications, such as helical gears and many industrial parts, because the alloy's thermal conductivity makes it specially adaptable to the high heat involved in processing nylon. It has also been found particularly suitable for polyethylene because of its mold release factor, according to Healey. Healey pointed out that time advantages are also a basic factor in deciding on the beryllium copper casting process; a second mold to meet unanticipated demand can be readily provided and damaged cavities can be replaced quickly since a hob can be submitted for additional castings to be delivered in most instances within a week of the receipt of the hob.

Healey concluded his talk by stating that a better understanding of what can be done utilizing beryllium copper will make it possible to keep pace with the trend in design toward more decorative and colorful plastic components. Healey said that beryllium copper should never be used as a substitute material, but rather to fill a definite need that meets specific requirements.

Healey was followed on the program by W. J. B. Stokes who spoke on "Electroformed Cavities." Stokes explained that the use of electroforming of molds is a completely new method and offers many advantages in the making of molds. Electroforming is the making of a metal part by plating just as in conventional chrome plating, nickel plating, etc., by plating until a very substantial thickness of metal is built up. The metal used for the mold surface in the electroforming of molds is nickel with a percentage of cobalt, Stokes said. Stokes advised that a nickel cobalt layer to a thickness of 5/32 of an inch is used and then an additional metal which is a crystalline form of copper having a hardness of approximately 220 Brinell is then plated on to a very substantial thickness. The initial nickel cobalt layer has a hardness of approximately 45 to 50 Rockwell, Stokes said, and even at this hardness this nickel is very tough. It is non-corrosive and need not be chrome plated for molding vinyls and other corrosive materials and it does not need the protection in storage that steel cavities do, Stokes said.

Stokes advised that the process of electroforming is started with a model known as a "master," which can be made of almost any material, although plastic or brass are generally used. The model must be made to the exact size and shape of the cavity that is desired and must also have the finish desired in the cavities. Multiple cavity molds require as many masters as cavities to be made and this is done by taking the original master and making a proto-type cavity from it, which consists of the plating of a very thin shell, just enough to be rigid, into which various materials can be cast to accurately reproduce the original master, Stokes explained. Masters so produced are prepared for the electroforming bath, coated with a conductive silver coating and attached to electrical connections for electroforming. This puts on about 5/32 inches of nickel and at the end of twelve days the pieces are taken from the nickel bath and put directly into the copper bath which puts on copper at the rate of 1/32 inches per day, Stokes said.

Richard Savage concluded the speeches by discussing "Molds for Low Pressure Molding of Reinforced Plastics." Savage pointed out that the same factors govern tooling for low pressure molding as govern injection molding tooling, namely, economics, molding method, number of units to be produced and size of part to be molded.

Savage stated that hand lay up tooling used to consist of anything that allowed the fabricator to get a shape; tooling for reinforced plastics was pulled out of the air. However, tooling in the reinforced field today requires workmanship and design as in any other field and the conception that tool costs are cheap is a fallacy.

Savage stated that the fastest type of molding in this field is the use of machined metal dies where surfaces are machined to tolerance to present accuracy and high quality. Lighter materials may be used for dies than in injection, compression and other types of molding, Savage said, and the requirements for low pressure molding of reinforced plastics in general are quite different from the requirements in the other fields of molding.

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Your National Office . . .

(Continued from page 11)

A PLASTICS ENGINEER IS

"An engineer mainly concerned with the application of principles of engineering and allied science to the production or utilization of plastics materials." This is the definition recommended by the Society's Education Committee. Your National Council will be requested to accept this as the Society's official definition at its April meeting in Houston.

P. L. Underwood

Executive Secretary

Pilgrims Progress . . .

(Continued from page 20)

THE HISTORY OF PETER Y

The industrial history of Peter Y began in 1950 when Pete, after some misgivings, joined an old, well established company, originally a large consumer of rubber in its proprietory product which for this purpose one might describe as electrical conduit in all sizes,—and millions of miles. When Pete arrived on the scene, the B.B. Company had a full complement of rubber chemists in research and development, although it had not used a pound of rubber in years. In this erudite group, Pete, with a primary interest in plastics, felt about as conspicuous as a clam at low tide, but with an ingratiating personality he avoided massacre initially by assuring everybody that he knew nothing about anything. Within three months he demonstrated with one nail and a piece of plywood, how B.B. could save one million dollars a year with the expenditure of only $25,000. In this $100,000,000-a-year company, the cash register never missed a beat, management couldn't be bothered with trifles, and the suggestion went ignored! Not exactly encouraged by this introduction to modern industry Pete settled down to developing cheaper and better compounds to meet code specifications for the company product. In this field, where imagination had apparently died years before, he appeared by comparison, a genius, and hence fell under the appreciative eye of the Beaver Materials Co. anxious to expand its sales into the electrical conduit field. With an amicable agreement between companies he joined Beaver in Technical Sales, introducing Beaver Material on its molecular merits, where it had never been used before and running interference for the bell ringers and order takers who follow in his wake. If after only three months Pete had job-offers from two competitors and if, after only three months he had justified his whole year's salary and if, come hurricane, flood, or fire he still has a standing offer to return to B.B. Conduit at any time, you can hardly blame Pete for being mildly amused at one man's growth through engineering education.

In conclusion, here is some evidence of how engineers trained for the purpose, would be placed in the plastics industry if generally available, and how such personnel is actually being applied. Although the plastics engineer we have been discussing can probably make his greatest contribution in the middle-sized company which cannot afford to maintain an extensive research and development staff, such companies unfortunately are the slowest to appreciate the technical advantages to be gained by having such an individual. The question in such cases is "Can we afford to have one of these boys around the place?" From their performance the answer seems obvious,—"you can't afford not to!"

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From a cold start through a full production run, Sterlco's "fast service" and extremely high degree of sensitivity assure quick warm-up and accurate, automatic mold temperature control for faster production and minimum rejects.

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He will be responsible for costs, schedule and quality. Also for labor hours, material usage and machine output, checking results against standard requirements. He will work closely with the Engineering Department in developing improved manufacturing methods or tools. He will cooperate with quality control.

Age 30-45 years. Salary $6,000 to $8,000 — could be more. Reply to Box 755, SPE Journal, 34 E. Putnam Ave., Greenwich, Conn.

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DEVELOPMENT ENGINEER — Old established midwest firm desires experimental and development engineer in the fields of elastomers, adhesives, bonding problems, filiform plastics, fibers, wire, and metal forming. Applicant should be between 30 and 45, preferably a good chemical background and desire to make a permanent location. Reply to Box No. 455, SPE Journal, 34 E. Putnam Ave., Greenwich, Conn.

WANTED—Engineer to direct a department for the injection molding of Thermo plastics. This man is to direct the department of 3 or 4 dozen men and will be responsible for maintaining schedules for cost and quality, material usage, machine output, control of labor hours and meeting standard requirements. He must be capable of designing dies and represent the engineering department in developing improved manufacturing methods for tools. Kindly send resume to: EDMUND H. EITEL, Personnel Consultant, Box 125, Halifax, Va.

Executive Chemist — Director of New Products Development with proven technical ability in the field of adhesives, coatings, reinforced plastics, laminates, design and pilot plant operation. Creative thinker with 15 years plastics engineering experience in technical and supervisory capacities. Professional member of S.P.E., married and presently employed. Desires position as Director of Research and Development Laboratory in the plastics field. Excellent references. Seeks position offering greater opportunities and would desire to locate in the West Coast area. Reply to Box No. 855, SPE Journal, 34 E. Putnam Ave., Greenwich, Conn.

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PLASTICS (EXTRUSION) ENGINEER: Seeks more responsible position in production or development. B.S. degree in Ch.Eng. Ten years extrusion experience. Especially well versed in polyethylene film extrusion and related processing. Willing to relocate, Reply to Box A, 34 E. Putnam Avenue, Greenwich, Connecticut.

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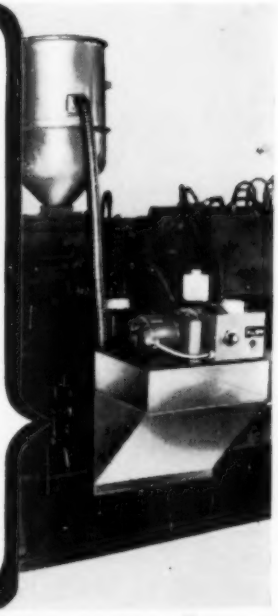

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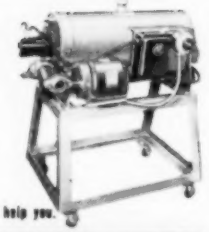

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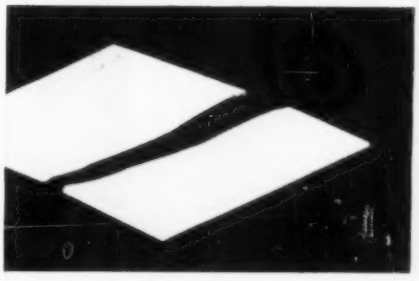

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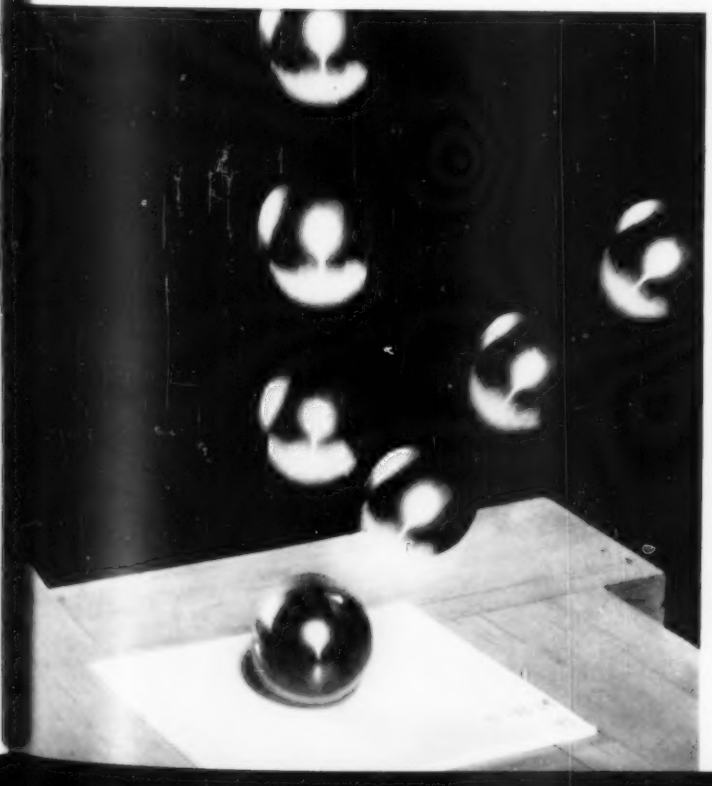

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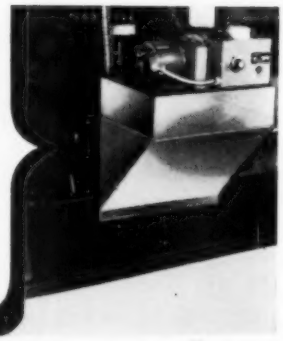

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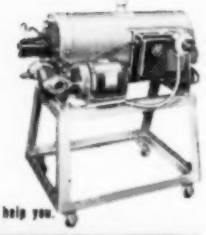

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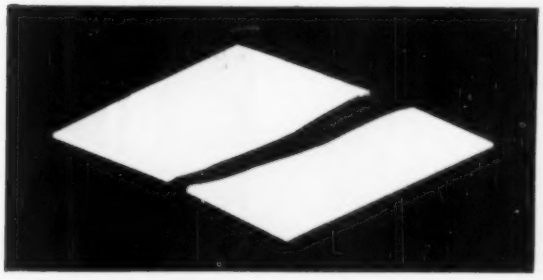

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